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**INNOVATION IN AGRICULTURE: HOW INNOVATIVE
EFFORTS HAVE BEEN PERFORMED AND WHAT
ENTREPRENEURIAL TOOLS HAVE BEEN USED IN
PORTUGAL**

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Abstract

Agriculture is one of the most important activities in the world, and has been so since the start of mankind. Additionally, the need for innovation in this area is progressively increasing, due to the growing needs of the society. The production of various products (meat, vegetables and fabrics, among others) has risen exponentially along with the growth of the human population. On the other hand, the effects that agricultural activities may have on the environment lead to the need of innovating how Agriculture is done nowadays. Furthermore, the need for innovation is also due to increasing costs that farmers face, along with other challenges that include the overuse of nutrients or water. Thus, innovation is greatly needed in Agriculture, in order to create solutions that will help respond to the problems farmers, and society, face every day.

Thus, in order to assess how innovation is done in Agriculture, specifically through the use of various entrepreneurial tools (Technology *Push*, Lead User method and Business Model Patterns), a study was developed. This study was done in order to understand how these different tools were used to create and implement innovation into the market, and how the innovation itself was created. The research work was then the development of a literature review regarding the main themes of Agriculture, Innovation and Entrepreneurship, along with the conduction of interviews with the main actors (Scientific Researchers, Entrepreneurs and Farmers) involved in the Agricultural Value Chain, with the analysis of three areas of Agriculture: Olive Grove, Vineyards and Fruits and Vegetables.

According to the results of the research, all of the mentioned tools have been used in Agriculture with success. Technology *Push* has been used previously in Agriculture, however more and more the Lead User method has become the methodology of choice when discussing innovation. The importance of the interaction between innovators and farmers is such that the information exchanged through a Lead User methodology can allow innovators to answer more effectively any challenges that the end-user mentions. Farmers, on the other hand, while having not shown any capacity to be the promoters of innovation, displayed a willingness to be involved in the innovation process, by acting as Lead Users whose information is crucial for the creation of products that are useful to them, and successful for the innovators. Furthermore, the use of Business Model Patterns can be of importance for Agriculture as there is a clear opportunity for further innovation in agricultural business models. The use of these patterns may then bring a foundation on which to improve the existing models. Thus, through the use of these different tools, the ultimate aim will be to create products that bring benefits not only to the innovator, but more importantly to the farmer, and Agriculture in general.

Keywords: Innovation in Agriculture, Agricultural Value Chain, Technology *Push*, Lead User method, Business Model Patterns, Collaboration.

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1. Introduction

1.1. *Personal Motivation*

I developed this research analysis so as to better understand which activities have been undertaken to improve and bring innovation to agriculture. Being in contact with agriculture for all my life, I have developed a comprehension of the great importance of its activities in the world, being a food source for every single person worldwide. As it will be demonstrated further along in the thesis, sustainable agriculture should be the ultimate aim, and so technological innovations are crucial to bring new methods and processes that will lead to this ultimate goal. Thus, through this work, I expect to further assess how innovation has been created in Agriculture, and what have been the main tools used to lead these innovative solutions into success.

1.2. *Research Objectives*

The main objectives for this research will be the realization of an analysis of the current activities that have been developed in terms of innovation of agriculture, in order to establish what type of work has been done to create and nourish innovation in Agriculture. Also, through the analysis of both literature as well as data gathered from interviews done with farmers, scientific researchers and entrepreneurs, the author will establish whether tools typically oriented towards entrepreneurship have been utilized in Agriculture. When mentioning entrepreneurs during this work, these This is will be done also in order to understand if and how these tools can be used bring success to innovative ideas that are developed towards Agriculture. This work will be done so as to determine whether these types of mechanisms bring some kind of advantage in terms of their use to improve innovation creation, implementation and acceptance within Agriculture.

1.3. *Research Relevance*

Agriculture remains one of the most important activities in the world, with its products bringing food to all of the world population, as well as fibers for various types of products used every day worldwide, from clothing to tapestry. As such, agriculture has to be considered a crucial activity for the growth and development of society. Accordingly, a greater demand for these products has also occurred, with challenges arising in agriculture, more specifically considering its sustainability and productivity. Because of this, and in order to respond to these challenges, innovation in Agriculture is needed in order to bring new methods to develop the various works that are part of Agriculture in a productive and effective way.

Sustainability is one of the main concerns within agriculture. Sustainable agriculture has been defined as “farming systems that are capable of maintaining their productivity and utility indefinitely,” (Ikerd 1990). For this to occur, new methods have to be developed, in

order to bring new, more effective ideas that will allow to tackle the various obstacles that exist against sustainability. Several of the articles written on the subject mentioned the existence of environmental, social and economic factors that will influence not only whether an innovative technology will be applied and accepted, but also if it will be successful (Lubell, Hillis et al. 2011, Kubankova, Hajek et al. 2016). Size of farms, age and literacy level of farmers, as well as the type of institution developing the research (Private firms or Universities), all of these affect the way that innovation is developed, and perceived, and so finding the best way to balance all of the factors is crucial to reach the goal of efficient and sustainable agricultural practices.

Considering then the need for innovation, various areas are considered and studied, in order to develop new ideas within agriculture. There are several instances and examples of various types of innovations being developed in agriculture. From the development of energy saving irrigation systems, to the development of new models regarding the use of arable land, a great number of study areas can be considered, when coming up with innovative ideas in agriculture. Different areas (Computer Sciences, Molecular Biology and Electrical Engineering, among others) may then be used, and intersected, in order to further improve the use of new technologies in agriculture.

1.4. *Research Methodology*

As it will be presented further along the thesis, the main methodologies used to develop this research work were literature review and analysis, as well as the development of interviews and the analysis of the data gathered from these interviews.

Regarding first the literature review, the research was done on Scopus regarding innovation in agriculture, in order to find articles and other documents that discuss the various themes regarding this main topic. The details regarding the research itself are present in the section *Research Methodology*, subsection *Research Design*.

The research question was reached not only taking into account the main objectives previously established, but also taking into consideration the findings of the research done with the literature review. Considering that through the literature review it was possible to create a greater sense of what Agriculture is, how innovation has been created in Agriculture, what are the main factors affecting it and how different Tools have been used in Agriculture, with this knowledge it was possible to develop a pertinent and accurate research question. The main research question is thus:

- “How can the different Entrepreneurial Tools (Business Model Patterns, Technology Push and Lead User) be used for the creation, development and management of innovation in Agriculture?”.

1.5. *Thesis Structure*

For this research work, the first main section presented will be Motivation and Context, where the current research on Agriculture and its context is described, along with a

description of how the different methods that will be under analysis in this research have been used in Agriculture. Also present in this section will be the Knowledge Gap, which will help then create the research question. Following this, the section Research Methods presents not only the main research question for this research, but also the methods that will be utilized to effectively develop this work as well as a brief discussion of the research process and possible limitations. Additionally, in this section the proposed approach for this research work will also be present, where the main model on which the research work is founded on is situated.

After this, the case studies under analysis will be represented in the Case Studies section. According to the data obtained from the interviews done for the research, the feedback and how it related to the research and the research question will be presented in this section, being separated into three different areas of Agriculture: Olive grove, Vineyards and Fruits and Vegetables.

After this, a Discussion section will be present, where the discussion of the data gathered for the previous section will be discussed, along with the information obtained through the literature review don previously. And finally, the Conclusion will be present, where the main conclusions of this research will be demonstrated, as well as possible recommendations of future work to be done related to this research.

Also present in this research work will be the Annex, where the interview guidelines will be present, as well as the Literature Review tables that include the articles and books that were studied for this research.

With this work, the author intends to answer the main research question determined for this analysis: “How can the different entrepreneurial tools (Business Model Patterns, Technology Push and Lead User) be used for the creation, development and management of innovation in Agriculture?”. This will be done in order to understand how innovation has been done in Portugal, the view of the various actors involved in Agriculture in what relates to Innovation, define clearly the main factors driving innovation in agriculture, and determine if and how various types of tools commonly used in Entrepreneurship can effectively be applied in Agriculture.

2. Motivation and Context

2.1. Agriculture in Portugal

Agriculture remains an activity predicated on the conditions provided by nature. Several natural factors influence how agriculture is developed, what types of crops to grow, and the time period in which the activity should be done. Along with this, crop yields and other gains related to agricultural activities will also be influenced by these various factors.

According to the yearly study developed by *Instituto Nacional de Estatística* (INE) regarding Agricultural Statistics, in 2015, the main products grown in Portuguese soil are Wine and Olives. Nevertheless, various other products are also grown in Portugal such as Cereal (including wheat, rye, oat, barley, triticale, corn and rice), Vegetables (including tomato, pumpkin, cabbage, greville, pea, garlic, carrot, lettuce and melon), Fruits (including apple, pear, peach, orange, cherry and kiwi) and Dry Fruits (including almond and chestnut). Regarding the regions where each type of product is grown, while Alentejo presents a higher production of Cereal Products, both the North and the Centre of Portugal present a higher production of both Fruits and Dry Fruits. Regarding the cultivation of olives, this is distributed all over the country, with a higher focus on this crop in Alentejo and Trás-Os-Montes. Regarding the production of wine, the North of Portugal shows a slightly higher production levels (INE 2016).

Another study developed by INE was the Agricultural Census of 2009, done in order to construct a detailed information database regarding agriculture, summarizing the main trends in the structure of farms and agriculture production systems in the years between 1999 and 2009. According to this study, the surface of farms still occupies half of the country territory, with the Utilized Agricultural Area (UAA) being, as of 2009, 3.668.145 ha. Of this, approximately 47% are Meadows and Pastures (INE 2011).

Through this study an analysis of the common farmer was also made. The average farmer is a male, of an average age of 63, with only the completion of the 1st cycle of basic education, has only practical agricultural training and works exclusively in activities on the farm about 22 hours per week. Most agricultural activities are developed by a single farmer (68%), with Agricultural Organizations representing only 27% of the total amount of producers in Portugal (INE 2011).

Considering the Portuguese Agriculture within the European Agricultural Context, Portuguese farms represent around 3% of total farms in Europe, with Portuguese UAA being 2% of the Utilized Agricultural Area in Europe. While Portuguese farms, in terms of average size, are below the European Average, they still present a higher area under use when compared with other southern European countries such as Italy, Greece or Cyprus (INE 2011).

2.1.1. Innovation of Agriculture in Portugal

Innovation in the area of Agriculture, within Portugal, has grown considerably during the last few years, as Agriculture was not a main focus of innovation, specifically technological innovations. Nonetheless, its growth has improved, with more and more companies being created with the purpose of applying new and innovative solutions onto Agriculture, in order to make it not only more efficient, but also more sustainable.

Most new businesses and start-ups arising in the field of agriculture tend to approach agricultural activities through a technological point-of-view, usually applying solutions previously used in other areas (Informatics, Health Sciences, and Economy, among others) within Agriculture. Below the author presents a couple of notable examples of start-ups who are active in Agriculture.

One example of a start-up is *Wisecrop* (<https://www.wisecrop.com/>). This start-up initiated its activity in 2014, bringing to farmers a data gathering and management system that could be considered equivalent to an operative system dedicated to Agriculture. With *Wisecrop*, users are able to control and establish more effectively the crop's yield, as well as the sustainability of the agricultural endeavour they are developing. Through the use of detectors and sensors, and also a data management system, this company brought an innovative way to increase the sustainability of agriculture, by allowing users to control potential pests or how much water is being used, for example, as well as determining the best times to grow a crop according to various information obtained from the environment.

Another example of success is *CoolFarm* (<https://cool-farm.com/>), founded in 2014, which specializes in developing smart control systems for indoor farming, whether in greenhouses or warehouses. Similarly to *Wisecrop*, users are able, through their solution, to achieve maximum efficiency, quality and profitability, using an automatic customizable and modular system, with the main focus being on the improvement of agricultural activities related to indoor farming specifically. As such, users can scale the product according to their needs, improving their culture not only in terms of production, but also in terms of financial burdens.

As seen with these main examples, one of the principal goals of innovation in Agriculture is to improve its sustainability, lowering not only the effective financial burden on the farmers themselves, but also lowering the burden on the environment by reducing various types of unnecessary uses of natural resources.

2.2. Agriculture in Europe

The study conducted by INE in 2009 also presented an overview of the status of Agriculture within various countries of the European Union (EU). According to this study, five different levels of activities of countries, or group of countries, were found where the unit work volume (UTA) per exploration (UTA/Expl.) proved to be higher than the European average (1,0 UTA/Expl.). Their following groupings were selected according to which type

of activity led to this level. As such, first, Denmark, Luxembourg, France, the UK and Germany (from 1,1 UTA/Expl. in the U.K. to 1,6 UTA/Expl. in Luxembourg and Germany), present a higher level of activity than the European average as a result of the large dimensions of their farms which are associated with intensive farming systems. Ireland and Finland (1,1 UTA/Expl. and 1,2 UTA/Expl., respectively) demonstrated similar levels of activity, however they represent another group of activity due to its farms of high dimensions. Following this, an higher level of activity was related to the Netherlands (2,2 UTA/Expl.), due its highly intensive agricultural activities, including the dairy sector and floriculture. Lastly, both the Czech Republic (3,5 UTA/Expl., the highest level found) and Slovakia (1,2 UTA/Expl.) presented higher levels of activity than the European average, mainly due to not only its significant size of farms, as well as its low degree of mechanization (INE 2011).

The overall land area available for agricultural activities within the EU, the total agricultural area being utilized is 174 million hectares (ha), comprising of around 40% of the European land area. Of this total are, 60% of it is arable, with 34% representing permanent pastures and grazing, and the remaining 6% being described as permanent crops (fruits, berries, nuts, vineyards, among other). Overall, a significant decline has been observed, due to increasing forestry growth, as well as urbanisation. Thus, a need for the development of solutions that will increase the productivity of agricultural activities is paramount for its survival, and potential growth (European Parliament 2016).

Regarding European farm numbers, as of 2013, there were 10.8 million farms in the EU, with the regular agricultural labour force being comprised of around 22.2 million people (European Parliament 2016).

In terms of the farmers, 31% of farmers are older than 65 years, whereas 6% are younger than 35. In terms of their knowledge, most farmers in the EU have not been formally trained in agriculture, with 70% having only had practical experience, 20% having received basic training and only 8% having attended a full agricultural training course. Concurrently with the previous analysis, higher numbers of farmers over 65 years (80%) have no training whatsoever (European Parliament 2016).

2.3. Innovation in Agriculture

Growth in agriculture as always been associated with not only an increase in productivity, but also it is associated with an increase in economic factors, as well as an increase in the environmental burden brought on the agricultural activities. Thus, an increased awareness regarding Agriculture's effects on a societal, environmental, and economical level is very important in order to further assess how the possible negative effects Agriculture brings to society can be mitigated.

Despite this, various events have led to a decrease in interest in Agriculture. For instance, reform of subsidies in agriculture has been heavily counselled, with World Trade Organization have repeatedly identified agricultural subsidies as needing reform, more specifically the EU Common Agricultural Policy. Due to the use of various subsidies on

Agriculture, and agricultural activities, higher prices have been practiced in the EU, when compared to other international markets, and so defining and arranging new methods to allow the subsidization of Agriculture without it creating an unviable market remains a challenge Kleijn and Sutherland (2003).

Besides this, intensive agriculture has also brought a great burden to the Environment, with the reduction in biodiversity being a great problem. Not only this, but also possible other hazards in the Environment arising from intensive agriculture includes the overuse of pesticides and herbicides, which can influence negatively the environment around the farm, or even rivers and other water sources near a farm. Thus, a great need for controlling and finding new ways to control and reduce the environmental burden of Agriculture arises (Kleijn and Sutherland 2003).

2.3.1. Factors influencing innovation in Agriculture

As demonstrated previously, developing innovation activities in agriculture can be influenced by various types of factors that determine if and how innovation will be developed in this area. In order to determine whether and how previous studies approached the analysis of the effects of these various factors in the development of innovation in agriculture, I developed a context factors table, present below. In this table, I established which factor was evaluated in each study, so as to define whether a factor has been taken into account or not.

Table 1. Overview of Context Factors previously analyzed in the literature review, which is located in the Annex.

Factors					
Articles	Social	Economical	Political	Technological	Agricultural
(Janssen and van Ittersum 2007)		X	X	X	
(Ervin, Glenna et al. 2010)	X	X		X	X
(Rezaei-Moghaddam and Salehi 2010)	X			X	X
(Temple, Kwa et al. 2011)	X	X		X	X
(Janssen, Athanasiadis et al. 2011)			X	X	X
(Lubell, Hillis et al. 2011)	X	X		X	X
(Leach, Rockström et al. 2012)	X				
(das Chagas Oliveira, Calle Collado et al. 2012)	X	X			X
(Cullen, Forbes et al.	X	X			X

2013)					
(Sumberg, Heirman et al. 2013)				X	X
(Busse, Doernberg et al. 2014)	X		X	X	
(Mekonnen, Spielman et al. 2015)	X			X	X
(Chetan Dwarkani, Ganesh Ram et al. 2015)					X
(Long, Blok et al. 2016)	X	X	X	X	X
(Kubankova, Hajek et al. 2016)	X				X
(Alarcón and Sánchez 2016)		X			
(Nasiakou, Vavalis et al. 2016)					X

As seen in Table 1, the papers under analysis in the Literature Review approach the theme of “Innovation in Agriculture” through various ways, discussing and exposing some of the most important factors when discussing innovative practices in agriculture.

Long, Blok et al., (2016), developed an analysis of potential barriers to the development and adoption of technological innovations in agriculture, having gathered information from various articles and studies, in order to define which main factors will influence innovation in agriculture (Long, Blok et al. 2016). As seen in the table above, various types of factors were found to influence the development of innovation in agriculture

Societal factors have an impact in the adoption of innovation, as, for example, the perception that users have of a new technology will influence its’ success. Accordingly, the societal structure in which farmers are inserted in, as well as their own societal background will influence how they will perceive a technological innovation which they may use.

The farmer itself remains an important actor when discussing innovation in agriculture, as he/she will be the actual user of the innovation, bringing it into use within a real environment. Rezaei-Moghaddam and Salehi developed a study regarding the attitudes and intentions of agricultural specialists towards innovation in agriculture, in Iran. It was observed that the acceptance of users when discussing the innovations is of great importance for the application and success of the innovation (Rezaei-Moghaddam and Salehi 2010). Another study emphasized the need for cooperation between the research groups and the end-users, as users present sometimes a certain “Knowledge Gap” that prevents them from fully understanding what the innovation is, and even how it works. This cooperation is then greatly important, not only allowing to effectively establish a relationship between the product developers and the end-users, but also possibly bringing new ideas onto the table (Lubell,

Hillis et al. 2011). As a whole, there is an apparent need, when discussing the development of new products, to establish a feedback loop that will connect the users and the developers in a way that will possibly lead to the development of a new and improved product, with a possible higher degree of success. This was reported by Sumberg (Sumberg, Heirman et al. 2013). Despite this, an important factor to consider is the farmers' own experience, and possible small scale innovations developed by them, that allow for a more effective agricultural experience. Other authors presented a study on the effectiveness of a specific "homemade" innovation by peasants in Brazil, that allows their agricultural activities to be more efficient, effectively reducing costs. According to this study, this innovation has led to significant improvements in both social and economic areas for the users, also improving land use for land owners (das Chagas Oliveira, Calle Collado et al. 2012). Thus, possible innovations by the users themselves remain of importance, as they present alternatives that may lead to a more sustainable activity. As a whole, only by determining their relevance, and how to involve them in an effective way in the daily activities of farmers, will it be possible to establish a successful relation between farmers and the innovation being performed in their area.

Another important factor found regarding society in general is its views and responses towards the environment, and how innovation in agriculture helps respond to that. Concerning specifically climate change, agricultural practices remain one of the most common producers of Greenhouse Gas in the world, and so developing innovative efforts, in order to change processes that lead to this pollution is crucial for the sustainability of not only of the agriculture, but of the world (Kubankova, Hajek et al. 2016, Long, Blok et al. 2016). As such, an important factor to take into account will be the environment, how it is affected by agriculture, and which activities must be undertaken in order to help create a sustainable and healthy environment.

Also of importance is the economical factor. The main factor concerning a possible financial effect on the possible potential use of innovations in agriculture is its financial cost. The need to apply significant amounts of money for the development of the technology, and its adoption, presents a considerable barrier, not only for the developers of the technology, but also for the farmers that will be the ultimate users of said a given technology (Cullen, Forbes et al. 2013, Alarcón and Sánchez 2016).

The diverse regulatory systems that have to be taken into account when developing a new technology for agriculture will also affect the willingness of a technologist to develop a technological innovation and pursue a commercial application of it in agriculture. This then presents the potential political barrier to the development of innovations in agriculture (Janssen and van Ittersum 2007, Janssen, Athanasiadis et al. 2011).

In what pertains to the technology related barriers to the development and adoption of innovation in agriculture, the main factors concerning the technology itself would be the development times being of a considerable amount, since in order for the technology to actually be developed and perfected, various months, and sometimes, years, will be needed for this to occur. Not only this, but the accessibility, or lack thereof, of the technology will also influence the perception of the user, and so whether the user will adopt the technology,

or not. The use of scientific jargon, as well the possible high complexity of the new technology may reduce the interest of farmers in using the innovation, sometimes reverting back to a more traditional method. Lubell, Hillis et al. indicate in the paper mentioned above that “Knowledge gaps pose a substantial barrier to practice adoption” (Lubell, Hillis et al. 2011), p.). It can be considered crucial the development of events and educational programs that will allow to connect more effectively farmers and technologists, in order for a greater understanding of the technology, demonstrating how it works and its benefits, as well as costs, so that users can be better informed about how this technology will change their activity, and so be more open to its adoption.

Finally, factors related to the activity of agriculture were also described in various studies. As expected, with these new technologies potentially being used in agriculture, a certain need may be answered. As such, the fact that this technology may or may not answer this specific need will also influence how an innovation will be perceived. Considering the study by Kubankova, Hajek et al., it was established that increases in efficiency in developing agricultural activities could bring positives not only for agriculture itself, reducing inputs used to grow and maintain crops, but also aid in other areas, such as the economic area, as this activity may be developed in a more cost effective way (Kubankova, Hajek et al. 2016). Connecting with a previous section, uses of innovation that can further improve agricultural activities may also improve societal factors, by reducing also outputs that may be prejudicial towards society, including environmentally hazardous substances. As such, consideration for the sustainability of the agricultural activities, and how the innovation may, or may not, enhance or improve this will also be of importance when discussing innovation in agriculture.

Another important finding is the importance of the sustainability that innovation brings to agriculture. As seen before, creating a sustainable agricultural activity is crucial, as developing such activities while reducing both inputs such as costs or nutrient usage, as well as outputs which may include pesticides and herbicides, and other products that may harm the environment, is of great importance not only for the future of agriculture, but also for the future of the world. Various articles show the importance of developing sustainable agriculture (Ervin, Glenna et al. 2010, Leach, Rockström et al. 2012). An example of the importance of developing agricultural activities in a sustainable way is the need to develop technical efficiency. Mekonnen, Spielman et al. (2015) developed a study concerning the analysis of production functions to estimate the level of technical efficiency in agriculture for various countries in Africa. It was observed that reallocation of resources, as well as increases in R&D outputs, as well as educational enrolments, leads to increases in efficiency. This increase, then, may lead to possible increases in the development of innovations in agriculture that will allow users to develop their agricultural activities in a more sustainable way (Mekonnen, Spielman et al. 2015). Other reports describe innovations in precision agriculture and smart agriculture systems, either working in the reduced input in the irrigation systems (Nasiakou, Vavalis et al. 2016), or using a smart sensing system to automate agricultural tasks (Chetan Dwarkani, Ganesh Ram et al. 2015). In both cases, these represent possible innovations that bring new ways to develop agricultural activities, using fewer resources, or developing the agricultural work in a more effective way, that leads to sustainability. Another possibility to develop agricultural work in a sustainable way is to

establish new models that indicating how the different inputs and factors that are involved in agriculture will affect its efficiency, and so allow to plan a more effective way to do agricultural work (Janssen and van Ittersum 2007, Janssen, Athanasiadis et al. 2011).

2.3.2. Precision Agriculture

Innovation in Agriculture has been approached from various angles and points of view, with solutions for possible needs ranging from the development of new energy saving systems or resource monitoring systems, processes that can be described as being a part of Precision Agriculture (PA), to the development of new business models or even the development of genetically modified crops. All around, innovating in Agriculture can be done in various ways, utilizing a great diversity of methods to reach an ultimate goal of making Agriculture more efficient.

Precision Agriculture (PA) can be described as a specific and comprehensive method applied to farm management, that is able, through its various activities, to increase profitability and sustainability of the farm, improve the quality of the product being grown in the farm, lead to a more efficient pest management in the farm, and help in the conservation and protection of water, soil and energy (Grisso, Alley et al. 2009). Through Precision Agriculture, farmers are able to control more effectively their farm and its processes, streamlining them and, at the same time, saving resources. Despite this, there is a certain resistance by farmers to use this type of technology, due to various factors such as Education, Age or Size of their farm. As such, only by effectively bringing to the attention of farmers of the positives of this innovative approach to agriculture will they be able to accept, and embrace, this innovation.

According to the study developed by the European Union in 2016 regarding Precision Agriculture and the future of Farming in Europe, PA not only brings gains to the various facets of life on Earth, but also presents significant needs in terms of skill that may restrict its use. As such, PA can make a significant contribution to food security and safety, by offering technological solutions that are more effective and also will further develop food safety and plant health. Also, according to this study, PA will help the development of Sustainable Agriculture, by improving this activities' impact on the environment, and also increasing sustainable productivity gains. Also, regarding society, it is expected that PA will help bring significant societal changes, due to the increase in its knowledge, but also by influencing how work and business is done on farmland. Despite this, several skills are still needed in order to effectively implement PA technologies, including technological skills and knowledge, environment knowledge and entrepreneurial skills. Only people who can master these areas will be able to approach PA in an effective and successful way (European Parliament 2016).

In terms of the technologies used for the practice of Precision Agriculture, its uses are varied, approaching agriculture through a variety of ways. These include object identification, geo-referencing, the measurement of specific parameters critical for Agriculture, Global Navigation Satellite Systems (GNSS). Also of importance is the use of

technology in innovative ways regarding connectivity, data storage and analysis, as well as advisory systems, representing technological solutions for Agriculture that will bring a higher level of productivity for users. Likewise, technologies related to robotics and autonomous navigation are also used, for the increase in awareness of the agriculture activities being developed in the farm, and also to increase the autonomy of these activities. Various PA technologies have already been applied in arable, vegetable and dairy farming. Nevertheless, this innovation may still be applied in other areas of Agriculture (European Parliament 2016).

2.3.3. Collaborations in Agriculture

A common point-of-view concerning the development of innovation is the importance of collaboration in the development of new solutions for Agriculture. The occurrence of collaborations and networking when discussing Agriculture is fairly common, with this type of activities having been developed for centuries. This can be seen in the article “The Role of Social Networks in Agricultural Innovation: The Sutherland Reclamations and the Fowler Steam Plough, c.1855-c.1885”, which describes how the Fowler Steam Plough was developed, as well as what was needed for this innovation to occur. This article explains the importance of associations and societies in developing and promoting new technologies in Agriculture during the 1850s and 1860s, demonstrating the importance of social networks which create the basis for the development and utilization of various innovations in Agriculture (Tindley and Wodehouse 2014).

An article regarding the importance of collaboration in the development of new applications within sustainable livestock farming can present a possible idea of the importance of an open form of innovation in all of Agriculture, not restricting only to livestock (de Olde, Carsjens et al. 2017). In this article, it was demonstrated that collaborations can lead to solution that are of a higher quality, and more efficiently, further providing the basis for creating new ideas in sustainable farming. Nevertheless, an emphasis is also made on that despite improving the creation of new solutions, collaborations do not maintain the promise of implementation of these ideas, as creators are generally subject to higher production costs, as well as the complex regulatory system commonly found related to agriculture. Not only this, but also found during this article is that the main disadvantages of the collaborative process were both the time and money invested, while the uncertainty about the market demand being considered an obstacle when developing relationships with the goal of finding financial backing. As a conclusion, the importance of helping and protecting innovators is promoted, as the importance of establishing a knowledge exchange between farmers, policy-makers and researchers (de Olde, Carsjens et al. 2017).

Innovations regarding the development of genetically modified crops have also been commonly considered, with the advents in DNA studies and engineering lead to the creation of new and improved crops. It is generally considered that the use and acceptance of innovations in genetics may be parlayed into breeding strategies which in and of itself can impact the rates of breeding gain. There is a need to improve breeding in crops as the annual rate of gain of production in farmers’ fields has diminished considerably for major cereal

crops. This then presents a serious need for new solutions that will help improve the yield of said crops, as the negative consequences can be felt worldwide (Flavell 2017).

Most new solutions regarding plants genomics have arisen from studies not connected to plant sciences and Agriculture, and so, understanding which innovations may be considered useful for Agriculture and remains an important challenge. Also of importance to consider, it has been discussed that biotechnological industries depend on public research more heavily than other industries which base their products on internal R&D. On the other hand, private companies have an influent stake in Agriculture presently. Considering agricultural patents, $\frac{3}{4}$ US biotechnology related innovation belong to companies in the private sector. Thus, how innovation is done within private firms will also influence the outputs developed by companies, as the sharing of information may be crucial for the development of new solutions, which typically does not happen with private companies (Flavell 2017).

Considering this, it is also of importance that knowledge regarding both the positives, and negatives, of these types of innovations is made available to everyone, as one of the most crucial factors that will influence the development and implementations of new innovations in this area is the public and market acceptance. Only through a thorough and comprehensive analysis, will mainstream understand and judge adequately if and how genetically modified crops should be used (Flavell 2017).

Establishing relationships and connections within the Agricultural world, then, presents an intriguing possibility for the development of new technologies and applications that will help grow Agriculture itself. Entrepreneurship itself then allows for the establishing of these types of relationships that will help control and develop how innovation is done. In the Article “Entrepreneurship and diversification on English farms: Identifying business enterprise characteristics and change processes” a great importance is given to the use of networking for controlling how change occurs within business (Clark 2009). Networking can help, as demonstrated in this case, shape possible diversification choices when discussing which farming activities to develop by a farmer, establishing the problems that a farmer might have, along with its solutions, and developing as well as implementing possible projects created in order to answer said problems. In this case, it was demonstrated that through networking, all of those involved got various benefits derived from the interactivity established due to the need to innovate, such as increased net income, greater income stability and a reduction in the dependence by farmers on agricultural subsidies (Clark 2009).

2.3.4. Entrepreneurial Tools used in Agriculture

Considering the application of specific tools commonly used in Entrepreneurship in to Agriculture, during the research for this thesis almost no article in academic research presented case studies regarding the use of these types of methods in the area of Agriculture. Despite this, it has been demonstrated that there have been developed works related specifically to the use of Business Model Canvas (BMC) in agricultural related activities, as well as articles based on a technological oriented market push for new ideas.

The article “Business Model Innovation in the Agri-food Sector” developed a review of what type of work has been done regarding the development of innovation in Agricultural Business Models, indicating the increased competitiveness in the Agricultural sector by small firms in the agri-food sector (Tell, Hoveskog et al. 2016). This then leads to the need for the establishment of new types of businesses that will help answer this increased competition, leading to them being more effective and productive. Once again, the importance of networking is established, with an example from Sweden being mentioned, where networks of entrepreneurs who work in Agriculture having replaced the large primary producers. In this case, the establishment of a network allows companies to circumvent their disadvantages, using still the various advantageous processes related to small producer independency. According to this article, the number of articles increased in a more significant amount around 2005, as the agricultural sector became a significant research area, with more than 50 articles being published in 2005. Nevertheless, the research itself on the agricultural area, especially more related to the agri-food sector is still in its infancy, with more than 50 per cent of the articles in the review having been published in the years between 2010 and 2014 (Tell, Hoveskog et al. 2016). As a conclusion, it is established that as the studies and research developed are still incomplete and rather weak, the study and use of Business Models and Innovation based on Business Models in Agricultural it's still too recent for there to be an established theoretical basis on which to define its research.

On the other hand, the discussion of Technology oriented innovations in agriculture has remained scarce, especially when considering the entrepreneurial aspect of it. Articles and reports based on the analysis of cases where Technology push was performed are rare, with most of them usually relating this method to other methods, including market pull. For example, in a study regarding the development of innovations of rice agro industries in a region of Brazil, it was found that while both market pull (or demand pull) and technology push methods were both used to develop and introduce an innovation into the market, in what pertains to the specific cases studied for this report, the demand presented by the actors within the market presented a more important factor in influencing the development of new technologies and services (Paraginski 2014). As such, demand pull was proved to be more important for the development of innovation in this area of agriculture, when compared to technology push (Paraginski 2014).

Another important aspect to consider when discussing the use of technology push to introduce technologies on the market is both the acceptance of said technologies, and determining its possible effects on the society. This is even more important when considering the modification of plants and organisms that will influence and affect Agriculture, as this will then influence not only the environment, but also the food available (Knols, Bossin et al. 2007, Flavell 2017). As such, determining exactly which influence these innovations will bring not only to Agriculture, but the world itself, will remain an important topic, especially when considering that these different innovations may be brought to the market through a method which the main aim will be to bring a new, and sometimes, unproven technology to the market.

Despite this, technology push itself remains influenced by various factors. Luong et al, in the article “Biosensor technology: Technology push versus market pull”, discusses some of the factors that will affect how a new technology is brought to market, specifically in this case regarding Biosensors, that will detect various types of attributes in plants and crops (Luong, Male et al. 2008). As shown in this report, despite a great development in the technology output, as research brings more and more information due to its work, the commercialization of said innovations has been significantly lower. This is mainly due, according to this article, to the significant costs that are related to the creation and marketing of a commercial product from the research work, as well as key technical barriers, that will impede the technology from being able to be translated from a laboratorial setting to the market, or in this case, field (Luong, Male et al. 2008). A possible solution presented to overcome these barriers would be to create products that are versatile and so possibly be used in different areas, with similar uses. As such, the fact that these products would applied to different types of use would then possibly bring a justification for the both the financial investment, and time spent, on the creation of innovation that would be pushed on to the market (Luong, Male et al. 2008). Thus, not only is important to create an effective innovation, when discussing technology push, but also to create an innovation that will answer the highest number of challenges that will be presented by the market that it will be inserted into.

Of course, other factors will influence the development of innovation when having a technology push in mind. The regulations in place will obviously influence how, where and when the new technology will be applied in the market, as more and more society as a whole has become aware of the importance in preserving the environment, and creating an agricultural activity that is safer and more sustainable in the long term (Horbach, Rammer et al. 2012). Ultimately, the view of the customer will also have an influence on the success of a technology that has been pushed towards a certain market, has only if the consumer will be open and interested in this new technology will that technology be accepted on to the market (Horbach, Rammer et al. 2012).

2.4. Technology Push, B.M. Patterns and Lead User Method in Agriculture

As demonstrated previously, innovation is of great importance to Agriculture, bringing new solutions to farmers that help improve their working conditions in various manners. Despite this, the interest in developing research work regarding the use of different entrepreneurial tools remains low, with articles related to either the existence or use of these different methods being scarce. Below is present a table with the listing of the main articles found on the literature search for papers related to the use of these tools in Agriculture.

Table 2. Literature Review for the Topic “Entrepreneurship in Agriculture”, with an emphasis in “Business Model Patterns” and “Technology Push”

Authors and Year	Title	Source Title	Keywords	Focus of Research
(Clark 2009)	“Entrepreneurship and diversification on English farms: Identifying business enterprise characteristics and change processes”	Entrepreneurship & Regional Development	“On-farm diversification”, “Business change processes”, “Business enterprise characteristics”, “Entrepreneurial behaviour”, “Economical benefits”	Analysis of the factors that affect diversification in farms in England, through a literature review and interview process with farmers, in order to determine which type of changes had been performed in their farms, and what socio-economic benefits the diversification brought to their business
(de Olde, Carsjens et al. 2017)	“The role of collaborations in the development and implementation of sustainable livestock concepts in The Netherlands”	International Journal of Agricultural Sustainability	“Collaborative efforts”, “Sustainability”, “Economic viability”, “Environmental impact”, “Social responsibility”, “Learning experiences”	Analysis of two case studies regarding the development of efforts in order to develop an innovative sustainable livestock production activity. This was done in order to understand what sustainability-related concerns exists, specifically related to the economic viability, environmental impact and social responsibility of livestock production
(Mekonnen, Spielman et al. 2015)	“Innovation systems and technical efficiency in developing-country agriculture”	Agricultural Economics	“Agricultural innovation system”, “Technical inefficiency”, “Knowledge transfer”, “Production enhancement”	Study, with the use of data from various countries, of how technical inefficiency in developing countries is influenced by various components of the agricultural innovation system in place. Components analyzed include the capability to transfer knowledge between institutions, as well as the number of articles published which is considered an indicator for research productivity
(Tell, Hoveskog et al. 2016)	“Business model innovation in the agri-food sector: a literature review”	British Food Journal	“Business Model innovation”, “Agri-food industry”, “Qualitative analysis”,	Determination of how both Business Models and Business Model Innovations have been utilized and developed in the agri-food industry. This was done through a literature review in order to understand which type of study, if any, had been developed related to this type of innovation

The articles above represent the bulk of the research that has been done in what pertains to the use of the previously mentioned methods in Agriculture, with a clear focus on the use of Business Model Canvas. Despite this, there is a clear opportunity to apply these various tools in a significant way in Agriculture, with innovation being more and more relevant in the agricultural scene.

The three tools under analysis are Business Model Patterns, Technology-Product-Market methodology (or also known as Technology *Push*) and the Lead User method. While

they are commonly used in the entrepreneurial world, its use in Agriculture remains underdeveloped.

Business Model Patterns

Business Model Patterns, as the name indicates, are archetypal business models developed using the common Business Model Canvas. They are then created as a way to construct common ideas among different areas, by applying similar business models in different sectors, or even just similar types of Business Blocks within different Business Models (Gassmann, Frankenberger et al. 2013). Many business models have been created, with businesses from very different areas being able to apply the same business model.

Technology-Product-Market (TPM)

In certain cases, a need may arise to look for a market in which to apply the technology which has been developed, in order to create economic value for the technology that was developed. Through the Technology Product Market (TPM) method, it is possible for technologists to find a market where the technology will be able to be translated into a successful product, effectively creating a Technology Push on that market (Markham and Kingon 2004). According to Markham this is needed due to the existence of a “Valley of Death” that separates discovery from commercialization (Markham 2002).

Thus, through this method, the research must establish the commercial value of the idea that was developed, and then create a product based on this idea. This idea then will be subject to a commercial analysis, creating a business idea around it so that it can be applied into a market. Thus, a previous idea or technology that had no apparent value can then be developed into a successful product with a verified market.

Lead User Method

The final methodology under analysis is the Lead User method, commonly used in Entrepreneurial contexts. The term “Lead User” refers to “users whose present strong needs will become general in a marketplace months or years in the future.”(A. von Hippel 1986). Through the Lead User method, it is possible to determine the future value of a new product or service, as lead users represent actors that have knowledge about the market in which the product will be applied in the future. Thus, through lead users, it is possible to forecast market feedback regarding an innovation. This can also be applied to the development of new products or services, as the knowledge of these users can also be used to response to possible needs in a market, creating new ideas that answer these possible challenges.

2.5. Conclusion

Knowledge GAP

There is a clear gap in terms of the development of efforts focused on understanding how these different entrepreneurial tools may be applied in Agriculture, and the response of the various actors to their use. As such, in this thesis, they will be analysed in various cases studies inserted within Agricultural and Technology research. As such, while Business Model Patterns will be applied taking into account the view of common farmers that have a regular contact with Agriculture and its markets, both Technology Push and the Lead User method will be studied while taking into account not only the farmers' perspective (specially Lead User method), but also the viewpoint of researchers that may have developed an innovative technology and entrepreneurs that are willing to apply, or have applied, innovative solution into markets related to Agriculture.

3. Research Methods

In this section the author will present the main research questions that will be the focus of this thesis. Alongside this the author will also present the methods that were utilized for the research work, in order to effectively answer the questions that were posed at the start of this thesis.

3.1. Research Questions

In what pertains to the main research question regarding the theme of this thesis, the question is:

- “How can the different entrepreneurial tools (Business Model Patterns, Technology Push and Lead User) be used for the creation, development and management of innovation in Agriculture?”.

One other question was also determined as being of interest for the development of this research work:

- “What has been the interaction between the different actors of this developmental chain for the creation, development and management of innovation in Agriculture?”.

3.2. Research Design

For the development of the research work that is represented in this thesis, two different approaches were done, in order to establish both a theoretical basis on which to work on, and also to define what has been done in Agriculture regarding innovation and the use of these different tools to further improve innovation.

A literature research as first developed, with a primary search being related specifically, and generally, to innovation in Agriculture. Accordingly, the keywords used for the search were “Innovation” and “Agriculture”, as well as “Innovation in Agriculture”. A previous search was also developed regarding new technologies currently being developed for use in agriculture, however the articles found were deemed as not fitting with this research topic.

This search was developed during the week of 21-27 of November of 2016, with 106 articles being found on Scopus. Through Web of Science, 38 other articles were found, most of which are present in the table located in the Annex.

Subsequently, due to the need to contextualize the use of the different tools under analysis within Agriculture, a second search was done during the week of 16 – 22 of April of 2017 in Scopus. The main keywords utilized were “Entrepreneurship in Agriculture”, with related keywords being “Business Model Patterns” and “Technology Push”. The number of articles found for both these searches was 78, with 12 having been deemed relevant. The articles are represented in a table regarding this second search in the Annex. “Lead User method in Agriculture” was also used, but no significant results were found

In order to obtain significant data that will allow for the study of the previous question, and to answer the goals previously established, the work developed will be based around interviews with significant actors in the agricultural sector. This, then, includes farmers, researchers that work in and develop technologies and other services that may be applied to Agriculture, and also entrepreneurs who have established businesses around Agriculture, particularly companies where innovation is a key factor for success. As a whole 6 actors were interviewed (3 farmers, 2 entrepreneurs and 1 researcher). Besides this, the author developed contacts with three more entrepreneurs as well as three more farmers, however due to a conflict in schedule, and in some cases an unwillingness to be interviewed, these interviews were not possible.

Three different sets of questions were developed, each tailored specifically to a segment of the actors involved in innovation in Agriculture (Farmers, Researchers and Entrepreneurs). These questions were created having in mind not only the research questions that were formulated in first place, but also the information that was gathered through the literature review phase. The three sets of questions are present in the Annex.

Another important part of the report is the selection of the specific areas of Agriculture in which the work would be focused. Three main areas were determined: Olive Grove; Vineyards; and Fruits and Vegetables.

First, the Olive Grove section of Agriculture was chosen to be a part of this study due to its great importance in the Agricultural sector in Portugal. Like previously mentioned, olive oil production is one of the most important agricultural productions in Portugal, presenting a significant part of the Portuguese economy. Alongside this, the researcher has also had a first-hand experience regarding olive oil production, with some understanding of how olives are gathered and then produced into olive oil. As such, a more personal experience was also behind the decision to make Olive Groves one of the case studies to be approached during this thesis.

Secondly, vineyards were also selected as one of the case studies. Similarly to the Olive Grove, this area was selected for an analysis due to its importance in the Portuguese economy. Wine remains the most important export of Portugal, regarding Agriculture, and so understanding how innovation has been, and may be, done in this area remains an interesting point of study.

Finally, Fruits and Vegetables were also selected to be a part of this study. This is mainly due to its importance in the local economy, as fruits and vegetables are still commonly produced in Portugal. Besides this, the nature of the production of these products on the field also is an interesting factor, when regarding the creation of innovation in this sector of agriculture. As most of this production is done through indoor farming, with greenhouses or warehouses, this then represents a more controlled environment, when compared to outdoor farming. As such, the development of innovation that will further help to control the crops being grown in these facilities will then improve the efficiency of these productions, and so determining how innovation is being done, and may be done in the future, will be of interest for this report.

3.3. Proposed Approach

The use of these types of tools (Technology *Push*, Business Model Patterns, Lead User Method) in Agriculture remains scarce, with no clear theoretical background having been established. Thus, in this thesis the author will bridge the existing Knowledge Gap, by applying these tools to possible cases in Agriculture, taking into account the various stages and actors of the Agricultural Value Chain.

Below we can observe a simplified version of the Agriculture value chain, where inputs that are obtained due to market demands presented by consumers are then applied into the production and harvesting of new agricultural products, which after processing are applied within the market, finally reaching the consumers. Of importance is the variability in terms of inputs that are available and important for the development of Agriculture. Not only the common feedstock (seeds, grain, among other raw materials) are needed to grow new crops, but also technological equipment must be available to develop such activities more effectively. Not only that but other services that allow for the determination of the efficiency of these activities are also of importance, allowing us to control and manage more effectively the crops being grown.

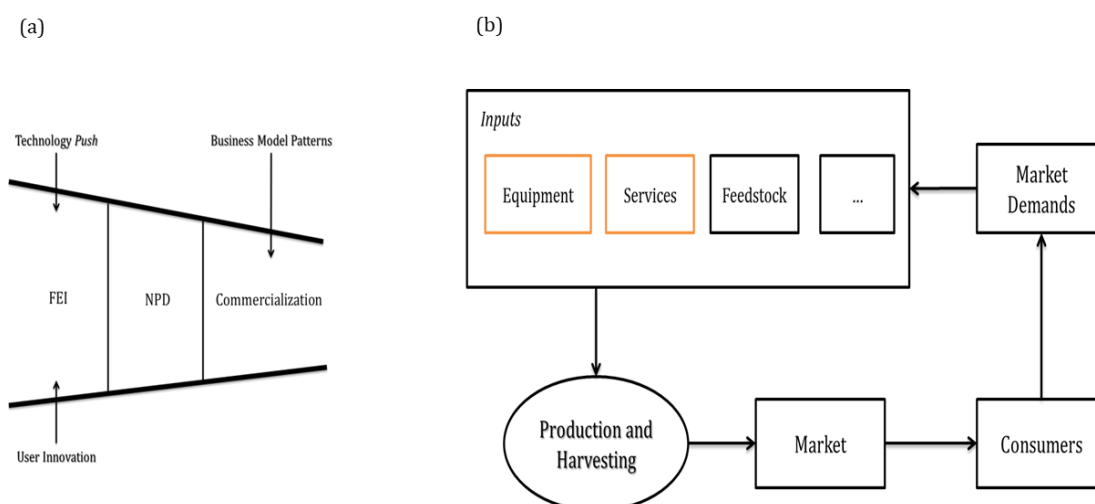


Figure 1. Schematic representation of the model illustrating the main research question of the thesis, connecting the use of various entrepreneurial tools (BM Patterns, Technology Push, User Innovation) applied within the Innovation Funnel (a), which may then be applied into the value chain of Agriculture (retrieved from http://www.africa.atkearney.com/sustainability/ideas-insights/article/-/asset_publisher/LCcgOeS4t85g/content/african-agricultural-transformation-opportunity/10192?inheritRedirect=false&redirect=http%3A%2F%2Fwww.africa.atkearney.com%2Fsustainability%2Fideas-insights%2Farticle%3Fp_p_id%3D101_INSTANCE_LCcgOeS4t85g%26p_p_lifecycle%3D0%26p_p_state%3Dnormal%26p_p_mode%3Dview%26p_p_col_id%3Dcolumn-4%26p_p_col_count%3D1) (b).

Despite this, in order for innovative ideas to be fully developed and matured in to a successful product, the development of an Innovation Funnel (pictured in Figure 1 on the left) may help develop such innovative ideas more effectively. It is comprised of three main stages: Front-end of Innovation (FEI), where ideas are first conceived and developed; New Product Development (NPD), where the ideas previously created are then applied onto a real

product that may be then applied on markets; and Commercialization, where the finalized product will then be commercialized on the market, according to previous market studies that allow the innovator to more accurately determine where the product might present an higher success rate.

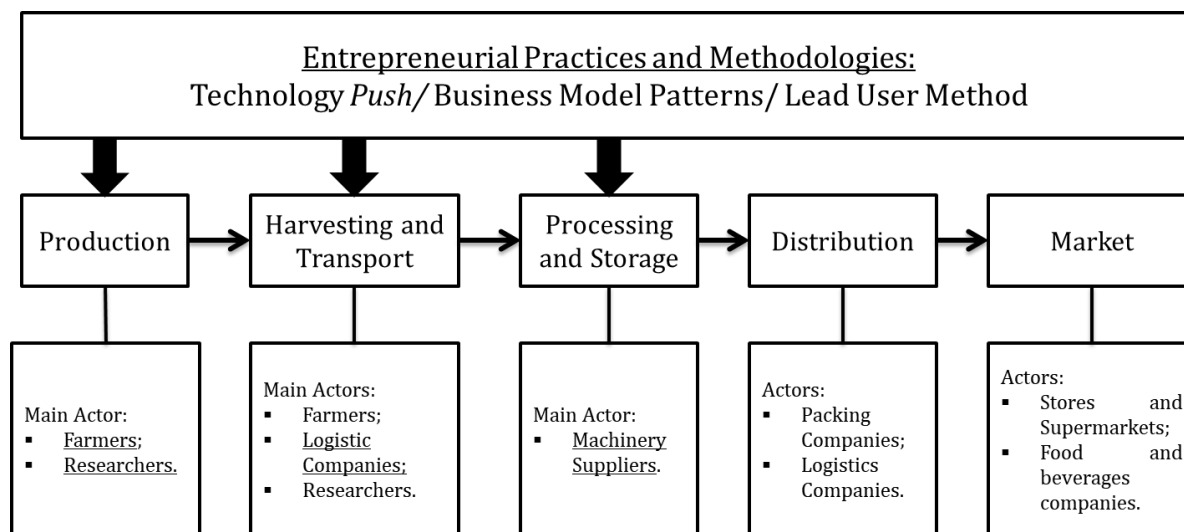


Figure 2. Proposed model for the analysis of Innovation in Entrepreneurship in this thesis. It is expected that the various entrepreneurial tools previously mentioned (Technology *Push*, Business Model Patterns, Lead User Method) will be used at various stages of the agricultural value chain, through the study of case studies in which the main actors will be Farmers, Researchers and Companies involved in Logistics and Machinery Supply, and the development of new technology for Agriculture. Created by the author.

The tools may then be applied, in order to bring this process further along and help improve its effectiveness. This is the basis for the development of the model presented above. As seen in figure 2, these tools can be used to help develop innovation activities in the various stages of the Agricultural Value Chain. As most innovation in Agriculture is directed towards the creation of new technologies that will improve agricultural activities and their efficiency, the main actors which will be taken into account when developing this analysis of case studies will be Companies involved in both logistics, and the development of machinery. These can be found in the Harvesting and Transport Stage, as well as the Processing and Storage Stage. Not only this, but farmers must also be considered of importance for not only Agriculture itself and its value chain, but also for the development, acceptance and success of innovative products. As such, another main actor which will be taken into account in this analysis will be Farmers. Finally, researchers will also be crucial for this value chain, as they develop the research work that eventually will need to the creation of innovative processes or technology that may be applied in Agriculture. Accordingly, Researchers will as well be considered during this analysis.

These different tools can then be applied at various stages of the agricultural value chain, with different actors participating it is development. The use of Business Model Patterns would be of interest to further improve or modify the initial BMC of the farmer as a whole (Gassmann, Frankenberger et al. 2013). By studying different types of business models that are in use in other areas besides Agriculture, it is possible to evaluate if those may be tested in an Agricultural setting in order to determine its success.

On the other hand, the use of Technology *Push* to improve the business model of farmer will be mainly focused on the development and innovation of the resources that are available to the farmer (Markham and Kingon 2004). The development of new technologies and services that would be of interest to the farmer would then be applied most directly towards the key resources that a farmer uses.

Lead User Method, finally, would then have to be applied in a two-fold manner, when discussing the BMC (A. von Hippel 1986). First, not only will the customer segment be of importance, as the actors (farmers, customers, distribution channels, etc.) that are a part of the customer segment will be greatly important due to their expertise and feedback that will allow for the better development of new technologies or services, or will allow to improve existing solutions. But the Lead User Method will also have an impact when discussing the resources available to the farmer. As was said before, the feedback from the actors that are a part of the customer segment will lead to the development of new and improved solutions for the farmer, which will be almost always considered to be resources of importance to the farmer. As such, this method will not only affect the customer segment of the farmer, by taking it into account when creating innovation, but will also influence the key resources available to the producer, since the ultimate aim of this method, like Technology *Push*, is to create new technologies, or resources, that will improve the agricultural practices of the farmer.

In general, the conceptual framework for the work that was developed during this research study can be represented in the figure below.

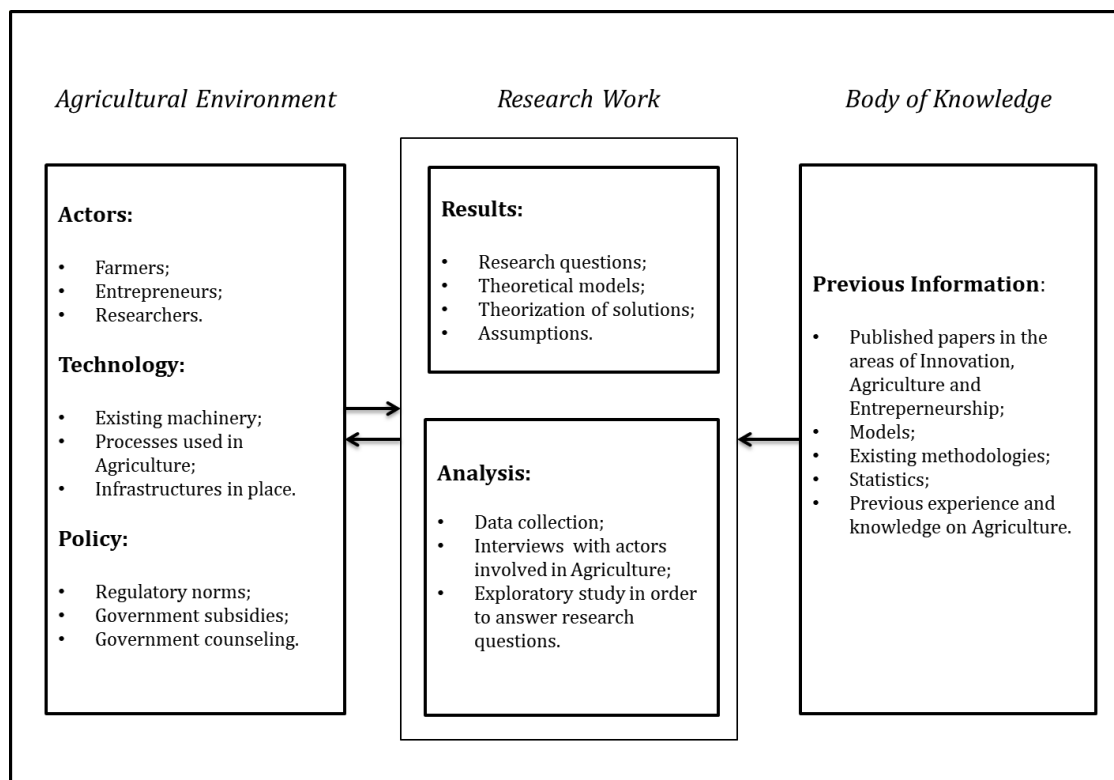


Figure 3. Conceptual Framework regarding the research work, and how it connects to both the already existing knowledge (Body of Knowledge), and the Agricultural Environment in place (Agricultural Environment). Created by the author.

As is represented above, the research work will be based around the analysis of various types of data. As such, for this research work, the author will perform a data collection, with the interview of the various actors involved in Agriculture. Thus, an exploratory study will be undertaken, in order to answer the research question elaborated previously.

Additionally, this work will be based on previous information that the author has researched through a literature review. Thus, information from published papers in the areas of Innovation, Agriculture and Entrepreneurship will be used to understand the theme of the thesis. Other knowledge include models regarding innovation in Agriculture, existing entrepreneurial tools, statistics about Agriculture and Innovation, and the previous experience of the author on the subject of Agriculture.

Finally, the results from this research work will include theoretical models and possible assumptions that will be elaborated based on the information received from the data collection and the interviews developed. These results will then be applied on to existing Agricultural Environment. On the other hand, the Agricultural Environment itself will also influence the research work itself. This is due to the various parts of the Agricultural Environment – the actors, the existing technology and the policies in place – being an active part of the research work, either through the data that the author will gather related to any of these parts, or the information received from the interviews that will be done with the actors of the Agricultural Environment.

As such, various concepts will be analysed and intersected during this research work, in order to understand more effectively how the various tools under study have been used in Agriculture.

4. Case Studies

In this section, I will present the results from the study regarding the development of the analysis on the creation of innovation in Agriculture, through the use of different methods. As mentioned in the methods section above, this study was based on interviews with the main actors of the Agricultural Value Chain, specifically in what pertains to the creation of innovation: farmers, researchers and entrepreneurs. A special focus was given to three value chains that are among the most important ones for the Portuguese Agricultural sector: Olive Grove, Vineyard and Fruits and Vegetables.

4.1. Olive grove

Olive grove crops remain an important part of Agriculture in Portugal, with its products being greatly used both in Portugal, and also with a high level of exports internationally. As such, the need to innovate in order to answer an increasing demand, and also to try to resolve the various challenges that olive grove farmers face lead me to develop an analysis of the efforts that have been developed in terms of innovation, in what pertains to olive groves.

For this subsection, two farmers were interviewed in order to gather their thoughts and opinions on the subject of the thesis. Determining the views of the end-users of the innovations that are developed is of great importance, in what relates to understanding how innovation is performed in Agriculture, and how the users perceive these innovations. Another important factor that influences the choice of interviewing farmers is the farmers' capability of developing innovations themselves. Therefore, determining if, and how, they developed and commercialized innovations is of interest for this analysis.

Technology Push

Since no clear feedback obtained from the interviews realized with the farmers indicated any connection towards the use of a *Technology Push* methodology, the data main data obtained from these interviews can be found in the Lead User methodology subsection.

Lead User Methodology

During the interviews with both farmers, feedback indicated that either farmer had not been involved in the process of developing an innovation. Nevertheless, they did present openness towards interacting with actors interested in developing new products that would help their activities, particularly researchers of that area.

The first farmer referred to a clear innovative effort, on his part, where the use of machinery for the harvest of the olives was considered the innovation. In terms of the innovations developed, first, despite not being, at this time, a clear innovative effort, this farmer emphasized the use of machinery for the harvest of the olives. The use of tractors along with vibration, or a gatherer with vibration to harvest this agricultural product was

considered by the farmer to be relatively innovative, due to the previous virtual non-use of this machinery. Nevertheless, nowadays this type of activity is common place. Despite this, the use of this machinery has led to an annual increase in 60% on the productivity of the harvest.

Another effort, in this case indicated by the second farmer interviewed for this section, this time related to production system, is the use of “green seeding”. This consists on the seeding of the soil with specific species, which are inoculated with rhizobium which increases the nitrogen (N) fixation improving soil fertility. With this type of seeding, the need for the constant use of manure is reduced, as the plant presents a symbiotic relationship with microorganisms at the root which can uptake N in a more efficient way. Besides this, as this type of seeding is able to keep itself dry when not necessary, it does not remove nutrients from other crops unless needed. Among other advantages brought on by the use of this type of seeding is that it eases the compaction of the soil, making it more fruitful, and stronger, also in case of rain. Thus, and particularly regarding weak soils, this remains an interesting solution.

While farmers demonstrated the importance of the use of these different innovations, either in processes or machinery, no interest was shown in actively being involved in the process of bringing an innovation to the market on their own. On the other hand, the farmers showed a willingness to work with researchers and entrepreneurs in helping develop new products, either through their know-how, or by lending tools such as data or field of work to help innovators create new solutions. Thus, while farmers may not be active promoters of innovation on their own, they have shown a capacity to be involved in the process of innovation. This willingness to help would then be of most importance to work that is developed when having in mind a Lead User Methodology.

In terms of work that is to be further done in terms of innovative endeavors, the main ideas mentioned were obviously directed towards actions in order to improve the work related to olive groves, and the challenges that have yet to be answered. More specifically, one of the aspects mentioned as being a potential point of study to further innovate in is the control of pests and diseases. This was exemplified by the recent occurrence of an invasion by bacteria of olive groves in Italy and Spain that has affected the production in these countries. As Portugal has a similar climate, it is possible to theorize that this bacterium will eventually appear in Portugal, and so work in order to innovate in the area of pest control remains of interest, in the opinion of this farmer.

Another idea mentioned was the need to effectively develop a database of existing arboreal species, in this case regarding olive crops. This would allow olive grove farmer's to have an index of what are the current available species, but also would allow choosing which would be most appropriate to their type of terrain, or even which species are resistant to a specific pest and disease. The index would not only indicate which species exist, but also their characteristics.

Farmers still face several challenges, and so more and more their feedback is crucial when discussing how to answer these challenges. Therefore, the use of a Lead User

methodology may then allow researchers and entrepreneurs to resolve these issues in a manner that takes into account the view and opinion of those who will eventually use these innovations.

Olive Grove Business Model Patterns

According to the interviews realized during this work for the analysis of the olive grove business, three main business models were mentioned:

- The farmer only harvests the olives, with the revenue stream arising from selling it to the olive oil producer. On the other hand, the costs of which the farmer is responsible are only related to the cropping and harvesting of the olive grove.
- The farmer harvests the olives and brings them to a grower association so-called “Cooperativa” or to a large scale grower pays them to produce the olive oil, which will then be gathered by the farmer. Thus, in this case, the farmer only uses this service to produce the olive oil, with bottling, distribution and selling the responsibility of the farming. In this instance, while the same costs as before apply, with the added costs of paying the mill for their service, and the costs of bottling and distributing, the revenue margin will also be higher, as farmers are able to sell directly olive oil to the final customer. As such, in this case, the producer may sell directly to the customer, or sell to different types of markets.
- The farmer harvests the crops, treats the olives and then sells curated olives to the market. In this case, the farmer gathers and produces the final product all by him/herself, with the costs being the same as the first business model, with the added cost related to the curation of the olives, as well as packing the olives and distributing. Similar to the previous model, the revenue stream is also directly related to the amount of olives directly sold to the customers, and so in this case the producer can also sell directly to the customer, or sell to different types of markets. Considering then the existing business models that may occur when discussing the olive business, there may be potential in the use of business models from other areas, and applying and adapting them to this specific agricultural area.

One possible business model pattern that may be adapted for this area would be the establishment of a connection between the customer and the product. Thus, the establishment of a Customer Loyalty type of business model, especially for the farmers who sell the product themselves, may be of great importance by improving the conditions of their customer base, increasing their chances of keeping them. This would be done creating incentives for their customers that they would not get with other brands of product. These incentives may include unique products related to the olive production, or give away of artefacts related to olive production, which may include special flasks where the olive oil may be carried.

Another possible business model pattern that can possibly be adapted for this area would be to give away experience to customers, mixing both the commercial aspect of olive production for the farmers and the experience in rural tourism for the potential customer. Therefore, the creation of an Experience Selling business model, for any farmer that harvests

olive crops, may be of interest. In this case, by selling the experience of harvesting the olive crops themselves may improve the experience of customers, also increasing their connection to that brand. Hence, with this type of business model, new customers may be brought on through this experience, who would not only be involved in the process of creating the product which they buy, but also may be offered samples of the product that they helped harvest themselves.

Finally, a third business model pattern that may be of interest for farmers may be an offshoot of the Rent Instead of Buy business model. In this case, instead of renting the product, the aim would be to rent out either specific olive trees, or most likely, areas of olive groves to customers. Essentially, and similarly to the previous business model, the main focus of the business model is to sell the experience of owning the actual olive trees, and so being responsible for taking care of it and harvesting the olives. Thus, the customer would, to some extent, be able to experience what is like to be an olive farmer, and so increase the connection to this specific product.

4.2. Vineyards

Wine is one of the main products exported by Portugal among its various agricultural products produced currently, with Portugal being of the top countries in the world in wine exports. Not only has this, but the commercialization of wine and grapes has remained an important part of the Portuguese economy. As such, an analysis of what has been done related to innovation in grape crops, and so vineyards, was then of interest for this research work. Interviews were done with one entrepreneur and one researcher, in order to obtain their understanding on the use of the previously mentioned tools in Agriculture.

Technology Push

As said before, one of the type of actors which were interviewed were entrepreneurs that are or were involved in the creation of innovation in Agriculture. These actors were considered for the analysis as they represent a key cog in the process of innovation in Agriculture. Through their various activities, entrepreneurs will ultimately bring the innovative solutions to the market, and so the end-user. Therefore, their viewpoint on the use of the various tools is of great importance for this study. One of the companies under analysis was *Wisecrop*.

Wisecrop is, as mentioned before, one of the emerging startup companies in Portugal that is focused on creating and developing a new and innovative solution in Agriculture, by providing a centralized solution to all the Farmers through its Operating System used to centralize Farm Management procedures. Through their solution farmers are able to go through their daily tasks more effectively, and in a quicker fashion, improving their agricultural activities.

For the creation of this innovation, the people initially involved in creating this solution started through the work that was developed while still studying in the University. The technology developed allowed for small devices to communicate in a very efficient way,

being able to deliver environmental data to the cloud and allowing the remote control of some domestic devices. Thus, while eventually the technology was purported to be used in an Agricultural environment, at first the agricultural use was not yet clearly established. Despite this, quickly was a first prototype directed to open farms developed, with 2/3 years after being the final product created and sold commercially.

As a whole, and regarding *Wisecrop* specifically, while we may consider that initially they operated under a Technology *Push* methodology, with an initial development of the technology with no clear market being the focus of the technology, as the product was more and more directed towards an agricultural application, the feedback from the farmers became more and more important for the better of the solution itself.

For the development of the market for their product, *Wisecrop* continually went door-to-door presenting the idea (and later prototype and product) to Farmers, collecting their feedback. Through this constant interaction it is possible to constantly update the software.

Regarding this case, it can be considered that a Technology *Push* methodology was used initially for the creation of an innovative product that helped control various processes autonomously. Nevertheless, the importance of the feedback brought on by the end-user cannot be forgotten, as the product has been constantly updated and improve according to the information presented by the users.

Lead User Methodology

An interview with a researcher was also developed, in order to understand the perspective from actors in this area who are mainly focused on the creation of new technologies that are to be directed towards a use in Agriculture.

The work that has been developed by the research group at INESC TEC directed towards Agriculture has been through different phases, with different tools having been used.

At first, research projects that were created would take the technology that they developed to the market, with the main lines of research being based not on market needs, but according to the current technological developments. Thus, early on in the development of research projects, a Technology Push methodology was implemented. In this first instance, the technology being developed was pushed towards a market most suited to the innovation that was developed, disregarding initially the end-user and their feedback on the innovative solution.

Despite this, in 2014, the Portuguese government, along with UP, and so INESC TEC, started a program directed towards the development of agricultural practices, mostly directed towards Precision Agriculture. Accordingly, the main uses would be for the measurement of various types of data (heat, production, quantity of different types of chemicals, quantity of water used, etc.) and the use of robotics for the development of agricultural activities in an effective and secure manner. The main areas of application considered were hillside crops (among which vineyards), protected crops, and the gathering of mass from forests.

Regarding specifically the main project, which is still underway, this project is directed towards the use, in vineyards, of robots that would make the harvesting more efficient, and eventually more cost effective. Thus, the technology would act on the four main phases in vineyard production - Monitoring/Spraying/Pruning/Harvesting - with a semi-automated robot being developed towards the idea that it would eventually be able to realize all of these activities. This would be possible since the main functionalities of the technology would be navigation, environment perception, type of terrain, Operational control and security. Thus the robots used in this innovative process would be able to navigate the irregular terrains of vineyards in a safe and effective way, being also then possibly able to do all the previously mentioned activities semi-autonomously. Currently this project is still underway, however during its development, the researchers have continuously asked for feedback from the farmers, which will allow improving the technology in a way that is more suitable to the end-user.

Regarding this case study related to the research project, it is possible to observe a clear difference in approach by research projects when discussing the creation of innovative technologies. At first the technologies developed were first created without a clear market and mind, and so pushed at a later date towards a certain market. Thus, they underwent a “Technology Push”. In spite of this, currently end-user feedback is more and more important, with product development first starting by listening to the feedback from farmers, where they indicated the main challenges and problems that they face. Nowadays most of the projects that are developed at INESC TEC regarding Agriculture are started having the end-user first in mind, with their feedback being crucial in the development of a new product.

One other project of interest is related to the previously mentioned robotics project. In this case it is related to the gathering of biomass from forestry, leading not only to the cleaning of the forest (as this mass is usually highly combustible), but also bring additional material to use in various types of areas, recycling the material. As a whole, while the projects are still underway, the feedback obtained from each innovative effort has fed into the other projects, in order to improve the work that is yet to be done.

Vineyards Business Model Patterns

An analysis on the use of Business Model Patterns in the area of Vineyards and wine production was not possible, as the realization of interviews with farmers were not possible in this particular case. Thus, no credible feedback regarding this tool was obtained.

4.3. Fruits and Vegetables

As common products used every day by millions of people in Portugal, and worldwide, the production of Fruits and Vegetables remains an interesting area where innovation can be further developed. Due to it also possibly being developed in a controlled environment, which includes the use of indoor farming, the possibilities of creating innovative solutions to problems arising in the production of Fruits and Vegetables are greatly increased. Thus, an analysis of case studies regarding innovation in the production of

Fruits and Vegetables is of great interest for this research work. For the Fruits and Vegetables case study, interviews with an entrepreneur and a farmer were performed.

Technology Push

As with the Olive Grove case study, no clear connection was found between the innovative efforts made either by the farmer interviewed, or the entrepreneur interviewed. Thus, the main feedback obtained from the interviews with these actors is located in the Lead User Methodology subsection.

Lead User Methodology

In order to understand the view of entrepreneurs in the development of innovation in the area of Fruits and Vegetables, a representative of *CoolFarm* was interviewed.

CoolFarm is also an emerging startup company whose main goal is to grow, in an indoor environment, local, fresh, nutritious and delicious food for a continuous annual period, while preventing losses in waste and creating a safe environment for the production. As a turnkey system, the product developed by this company is a closed and vertical system with a clean and acclimatized environment inside, allowing the growth of premium seedlings, flowers, fruits, vegetables, among other crops. Its efficiency is demonstrated by its lower uses of water, and the lack of use of pesticides or herbicides. A key aspect of the product is that it is modular, with each module being possible to be applied either vertically or horizontally.

In order to create a technology, first there was a focus on the need presented by farmers. In this case specifically, identifying the problem of waste in indoor farming, as well as the potential overuse of products such as pesticides and herbicides, led to understanding that a solution that allowed for the prevention of these lasting challenges would be intriguing for farmers. Thus, the idea for this product was created, with the team for the development of the product being formed, in order to tackle the creation of the commercial product. After developing a prototype, this technology was then presented to partners, which include specific clients, in order to obtain feedback on the solution. This feedback then allows for the continued development of the product, with continuous improvements, while the product is marketed and sold.

A Lead User methodology was then used in the case of *CoolFarm*. Through the information obtained from interviews with indoor farmers, particularly their waste problems and pesticide overuse, it was possible to create a team directed towards the development of a product that would provide an answer to these problems. With the feedback from the end-user, *CoolFarm* is constantly improved, with the innovation being constantly fed by the know-how of the lead users.

Specifically in what regards to the market, while with a revolutionary product, or a product that requires market creation, it is necessary to evaluate the technology introduction timing and implement it slowly, setting commercial strategy that allows educating the target audience and showing the added value of the product, in this case, as the product was formed by having first in mind the needs of the customers, the market is already created with farmers having an idea of what advantages this product brought. As such, in this case, market entry

was more "simplified", with the main goal being to disseminate the information properly to partners.

A farmer involved in the growth of Fruits and Vegetables was also interviewed, in order to obtain his perspective of innovation in Agriculture, and the use of methodologies to improve the creation of innovation.

The feedback presented by this farmer was mainly related to the challenges that he considers as still relevant nowadays. This was due to disregard shown by the farmer towards innovation, with his main focus being the production of his crops. Despite this, once again a great willingness was shown to potentially work with researchers and entrepreneurs in the development of innovations that would make the agricultural activities easier for the producer. An openness of the farmer towards a regular interaction with innovators was highlighted, as the importance of such a relationship was emphasized by the farmer. Consequently, the participation in an innovative effort was demonstrated, with the farmer being able to provide know-how that, as an end-user of the innovation, may prove to be of great importance to its success.

Besides technology related problem, problems related to the various infrastructures that regulate these agricultural activities were also discussed. A lack of exchange of information was mentioned in what relates to the production activities, particularly regarding discussions with the regulatory entities. Farmers demonstrated a certain frustration with the apparent lack of supervision by regulatory entities in what relates to the activity itself. As such an effort to improve relations between farmers and regulatory agencies, which may include an increase in online interactions, is important for farmers.

On the other hand, a lack of interaction between producers was also presented as a challenge. It was indicated that a potential great benefit would arise from a certain level of information exchange, not only in terms of production, but also in what relates to how the market is, and has changed. Thus, a potential chance for innovation is displayed, as developing a solution that brings farmers together in a way that is both safe and advantageous for them is of great interest for farmers

Fruits and Vegetables Business Model Patterns

In what relates to the area of Fruits and Vegetables, two main business models were determined.

- Producers are able to grow, harvest, clean and deliver the various products within a certain radius, with the possibility of delivering to clients punctually, within the country. This business model is used usually by smaller producers who don't sell to large scale retailers, and particularly those who practice Biological Agriculture. Related to the smaller size of these producers, the range of products is also more adaptable to the needs and wants of customers, increasing the personalization of the service to each customer. This can then be considered a deviation from the normalized business model where farmers sell their products to retailers, entering then a From

Push-to-Pull business model, as flexibility is increased, and a decentralization of the business occurs.

- Producers may just be interested in growing the different crops and harvesting them, then selling to larger scale retailers than just small farmers markets.

As demonstrated above, and similar to the previous case studies, farmers are able to decide which type of approach they take to bring their products to the market, according not only to their capabilities as producers, but also the customer base they wish to reach. As mass producing farms reach more clients through retailers, smaller farmers and organic farmers will try to reach their customers more directly, and so approach both the market and the distribution of the product in a different way.

Nevertheless, different approaches may be idealized, according to the existing Business Model Patterns.

One possible Business Model that may be applied for this area would be Experience Selling, as previously explained for the Olive Grove business. In this case, the added benefit of allowing the customer base to help in harvesting whichever product they wish, with the supervision of the farmer, would help ensure that the customers are ultimately satisfied with the vegetable or fruit they chose, bringing also fresh products to the client, or in this case, clients to the fresh product. Thus, potentially using this business model would allow for a greater connection between the farmer and the client, and more importantly, the product and the client. While more dedicated to smaller farms, large scale producers may also allow for this type of event, by limiting certain areas for this type of activities. This could also be considered as part of a Self-Service business model, where customers would be able to choose which products they would like to take, and also wash and bag it themselves, paying the farm owner after the final product is bagged.

Another potential intriguing Business Model to be applied in the Fruits and Vegetables area would be an Open Business Model, specifically to be used by small scale farmers. One main challenge for farmers, in particular of a smaller scale, is the lack of communication that sometimes occurs between them. Through the creation of incentives that increase this connection between different small scale farmers, they would be able to improve their own productivity, through the exchange of experiences and information. Not only that, but through this business model, it would be possible to find new ways to add to their product catalogue, either through the creation of new crops, or also improve their interactivity with the market, with the discussions with suppliers and interactions with the customers potentially changing as well. As such, collaboration between producers would potentially improve their working conditions and business foundation.

One final business model that may be used in the Fruits and Vegetables area is the Subscription business model. Through this business model, customers would have access to fresh products weekly or daily, by paying a weekly or monthly fee to farmers. In this case, the company is able to generate a steady income stream per month, while customers are guaranteed that they would have access to fresh fruits or vegetables in a daily or weekly

manner. This then not only brings financial benefits to the company that produces, but also increases the trust and loyalty of the customer to that particular brand of fruits or vegetables.

4.4. Discussion

Innovation in Agriculture is becoming more and more important for today's society. The need to produce food and other types of products that are derived from agricultural activities is of great concern as the world population continues to grow every day. Not only this, but arising concerns regarding the environment and the effects of Agriculture on potentially changing the environment lead to the need to develop different ways to perform Agriculture. Meanwhile, while farmers must be able to introduce these innovations in to their activities having in mind these different challenges, their own survival is also dependent on the costs that may be brought on by the use of the different innovations, with these growing costs pertaining to the overuse of nutrients, water or energy, among other factors (Long, Blok et al. 2016). Thus, the need to develop efforts in order to create solutions that are able to answer all of these challenges is one of the greatest undertakings ever done by mankind.

The goal of this study was to determine how the different efforts developed within innovation in Agriculture have been approached and grown, so far. This was possible by establishing a study in to which tool, if any, was used to create and implement innovation into the market, as well as how this innovation was developed. This was done through not only an extensive literature review regarding innovation in Agriculture and the use of entrepreneurial tools in Agriculture, but also through the realization of interviews with the various key actors involved in the creation and establishment of innovation in Agriculture. This then include Scientific Researchers, Entrepreneurs and Farmers.

Some differences were found when discussing which type of view the different actors had regarding innovation, and specifically innovation in Agriculture. While farmers view innovation as a mean to bring better efficiency and possibly lower costs to their activity, while also leading to a decrease in the agricultural activities' impact in the environment, the view portrayed by both technological entrepreneurs, and to some extent researchers, is related to a more technical level, relating it not only to the higher efficiency and lower costs it may bring, but also components that are more technical in nature, such as a lower margin of error that may be allowed through the use of specialized innovative systems or improving the data gathering conditions of a measuring system. Thus, while farmers will be more interested in the effects that the innovations will bring directly towards their activity and how what advantages it brings, the actors involved typically will be interested in this particular challenge, but also will be concerned with how the technology itself will behave in a real life application, and how it can be continuously improved.

A main focus of this research work was also to understand if and how different tools that are typically applied in Entrepreneurship were used in Agriculture, by the different actors involved in the Agricultural Value Chain (Researchers, Entrepreneurs and Farmers). Three main tools were analysed: Technology *Push*, Lead User method and Business Model Patterns. This was done through both a literature review, and through the feedback obtained

from the interviews with the actors. Below the author provides an overview of what tools were studied in what relates to each of the value chain processes.

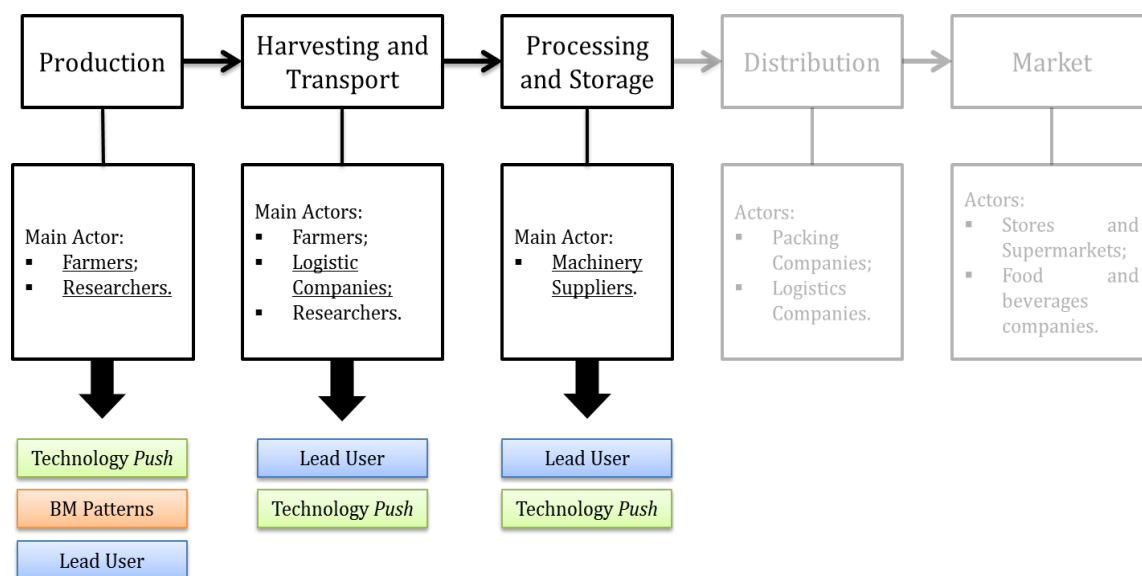


Figure 4. Overview of the tools that were analysed in each of the processes that are a part of the proposed model for the analysis of Innovation in Agriculture. Created by the author.

Technology Push

Technology Push remains a commonly used methodology in various facets of entrepreneurship, helping to find the best suited market for a technology that was developed with no clear marketing direction in mind (Markham and Kingon 2004). *Technology Push* has been used in various manners, bringing technologies to different markets after their creation, demonstrating its flexibility in application (Markham 2002, Horbach, Rammer et al. 2012). With this type of methodology, the opinions of end-users take a backseat, with the analysis of the various markets taking an increased importance.

The feedback obtained from the interview with the researcher indicated a clear difference in approach that has occurred in the researching world, in what relates to innovation in Agriculture. At first technologies were developed with no clear market in mind, with a push towards a certain market occurring at a later stage. *Technology Push* was, at the time, used for new solutions created by research projects. In spite of this, the current trend in research is directed towards the creation of innovations having first in mind the feedback from the end-user. In the case of Agriculture, research groups, before initializing the development of a new product, will first interact with farmers in order to gather information regarding the main obstacles that producers face currently. Therefore, in the case of research, a change in how innovation is done has occurred. While at first technology was pushed towards certain markets after its development, nowadays the focus of the innovative efforts is placed first on the needs of the end-user. This indicates, then, a change from a *Technology Push* methodology to a *Lead User* methodology.

The feedback obtained from the entrepreneurs, in what pertains to the use of Technology *Push* for the creation of new products indicated differing perspectives when discussing how innovation can be done. While *CoolFarm* clearly demonstrated that for the creation of their innovation, a Lead User method was used, in the case of *Wisecrop* that is not as clear.

Regarding the *Wisecrop* case specifically, while customer feedback remains crucial for the success of the product currently, the initial effort to develop a new product could be related more accurately to a Technology *Push* methodology. In this case, the workgroup was created and the technology was developed with no clear market in mind, even though Agriculture was one of the markets viewed as of interest for the development team. Thus, the technology was first developed and only at a later stage was the product pushed towards the Agricultural industry. Nevertheless, with the establishment of Agriculture as the market for this innovation, the interaction with farmers became decisive for the success of the final product, as the development team has continuously improved the product according to the data gathered from the users of the technology. As a result, while a Technology *Push* methodology was used for the development of the innovative product, the feedback from the end-user proved to be important at a later stage in the life of the product, helping make it a success.

Concerning farmers' views on this methodology, no clear interest or connection between the development of new ideas and the use of this method was established. Farmers typically do not present a clear understanding of how innovation is done, nor what methodologies are available to develop that innovation. In any case, the feedback presented when discussing innovation indicated an interest in interacting with researchers and entrepreneurs in a manner that would lead to the creation of new products that would benefit them. It can then be said that farmers would then be interested in being part of an innovative effort, by presenting themselves as lead users.

As a whole, it was observed during this work that Technology *Push* can be considered a viable methodology to use in innovative efforts in Agriculture, since technologies have been shown to be capable of being directed towards a use in agricultural activities in several cases, even from other areas (Flavell 2017). Nonetheless, even in these cases where Technology *Push* was used, the feedback from the end-user also played a part, if not in the creation of the innovation, in the continuous success of it.

Lead User Methodology

As demonstrated before, the Lead User methodology brings the end user in to the innovative fold, essentially helping create a final product, with an importance being given to what the user's opinion about the technology is (A. von Hippel 1986). Through the use of the Lead User method, users are able to more accurately answer their market's needs, bringing the solution closer to what the end user actually wants.

In what relates to the use of Lead User methodology by researchers, according to the feedback from the interview with the researcher currently this is the methodology of choice, when discussing the development of innovation. Research projects, at the moment, typically

will first talk with farmers in order to obtain their perspective and learn which problems they face currently. This allows researchers to direct their innovative efforts in a more efficient way. Through this methodology the technologies that are produced are then tailored to the farmers' needs, improving not only the technologies' efficiency, but also the acceptance of the innovation by the farmers. The development of new technologies in Agriculture has been shown to be pushed usually by the need of the user or the market (Luong, Male et al. 2008, Paraginski 2014). Accordingly, the fact that research projects have directed their efforts towards an approach that is aligned with the current landscape in agricultural innovation makes sense, in order to develop technologies and potentially bring products to the market that are useful to the end-user.

The use of Lead User methodology by entrepreneurs was also studied during this research work. Like previously mentioned, while *Wisecrop* took an approach more based on the Technology *Push* methodology to develop their innovation, *CoolFarm* implemented a Lead User method to create their technology and help it grow.

CoolFarm, before even creating a development team, first interacted and established a relationship with several farmers involved in the area of indoor farming, who acted as lead users. This interaction allowed this company to establish which main challenges farmers faced during their agricultural activities, and so allowed them to create a development team more suited to tackle these challenges in a more effective way. This in turn allowed the product development team to create a new technology that would answer more resourcefully these challenges than other possible technologies already on the market. Through the use of the Lead User methodology *CoolFarm* was able to not only develop a technology that would be directed specifically towards the lead users which the company had been in contact with, but create a product which can then be used by any indoor farmer whose needs are similar to the lead users interviewed by the company, which has been seen before (Paraginski 2014). Despite this regular contact with farmers, additional efforts to improve their methodology are possible. More specifically, the use of Lead User Workshops may be of interest to companies. With Lead User Workshops companies, instead of interacting with only individual farmers, develop focus groups of several farmers, adding an extra layer to the Lead User process (Herstatt and von Hippel 1997). With this, the process of interaction among farmers may improve the experience, expanding the potential of the Lead User method to produce new ideas. Overall, it can then be considered that *CoolFarm* used, in a resourceful and successful manner, the Lead User method.

In terms of the farmers' involvement, or lack thereof, in the process of innovation through the use of Lead User method was determined through the conduction of the interviews. The feedback brought on by the interviews indicated that, at least currently, no efforts were done in order to actively be involved in this type of process. Despite this, the farmers interviewed also expressed interest in establishing some kind of relationship with researchers and entrepreneurs with the goal of creating new solutions to the problems that they face. Farmers, through their expertise and daily work, are able to understand continuously which are the problems that are affective to their agricultural activities (das Chagas Oliveira,

Calle Collado et al. 2012). Therefore, this capability turns farmers into effective lead users for innovators who wish to develop new ideas in Agriculture.

The farmers that were interviewed were not involved in any way with any process of innovation that uses a Lead User methodology, there was interest demonstrated in being lead users in certain situations. On the other hand, the farmers interviewed also displayed a definite lack of interest in actively developing new ideas and innovations themselves. Various factors will influence this stance. One factor is that their main focus is the production of whatever agricultural product they grow every year. The creation of new ideas remains a laboring effort, with a significant amount of time being needed to truly develop an intriguing idea, and Agriculture, as an activity, while occupy most of the time of the producer. As such, the focus will remain on the main activity that actually brings revenue to the farmer, independently of the challenges that they face every day.

Another factor is the lack of knowledge regarding innovation as a concept, and also basic knowledge on how to manage and commercialize said innovations. While entrepreneurs in their own right with the growth of their crops and selling of their agricultural products, this type of production is very different from the creation and commercialization of technological innovations. Since most of the farmers that are active do not have a background in a technological area (INE 2011), the need to educate these producers on what innovation is and how to be involved in innovation is then of great importance. Only if the farmers understand what innovation is all about, and interiorize what is needed to create and help grow an innovation, will they be able to effectively understand how new products function and how to use them to its maximum capabilities. This presents a possible obstacle, at least in short-term, to the slow acceptance of precision agriculture. The use of precision agriculture will typically lead to both economical gains and productivity gains for the farmer (Grisso, Alley et al. 2009, European Parliament 2016). On the other hand, the farmer won't be able to understand completely how this technology works, and so the farmer will show some doubt regarding the validity of the innovation, and the benefits that are related to them. Thus, bringing knowledge about innovation to farmers is of paramount importance, allowing them to have a chance to understand whatever technologies that might eventually have access to, in order to make their work easier.

An important gateway to improve farmers' views on innovation may be to develop and improve a constant connection between producers and researchers, be it from private institutes or from public facilities. The importance of collaborations has been described in various articles from various periods in time (Lubell, Hillis et al. 2011, Tindley and Wodehouse 2014, de Olde, Carsjens et al. 2017). Feedback from the interviews with farmers revealed that they consider that a certain type of relationship between farmers and researchers that are involved in research in an agricultural area is of great importance, also displaying some receptiveness for this type of relation to occur in the future. As explained by them, while the downside is minimal for the producers, as in most cases they only have to allow researchers to use their fields for data gathering or even just ask for the data itself from farmers, farmers have a lot to gain in terms of creating solutions for the problems that they face every day in their field of work.

Furthermore, the development of a department dedicated to the analysis of innovative work that is created by farmers may also be an action that leads farmers to present a higher interest in developing innovative ideas. It would essentially work similarly to Technology Transfer Office that functions within Universities, with a focus on innovation developed in Agriculture. The importance of TTOs in the commercialization of innovations developed within Universities has been described previously (Siegel, Veugelers et al. 2007), with potential existing for a similar impact on innovation in Agriculture. As an accompanying office, it would help educate farmers on how to improve on the innovation, presenting knowledge that is generally lacking among farmers.

When comparing Technology *Push* to Lead User method, we can observe certain differences that lead to each being considered intriguing for being used when developing an innovation, depending on the focus of the entrepreneur or researcher. First, while the use of Technology *Push* may allow for the work to be developed to be more flexible, without a clear focus on which market the technology should be directed to, Lead User allows innovators the act more efficiently within their own market, by answering directly to the end user. Furthermore, possible differences between the two methodologies may be related to costs and time spent on development, as while in a Lead User setting the innovator will already know where the technology will be applied, possible further developments may be necessary when a market is selected. Thus, while the Lead User method should be used when innovators have a clear idea of what market they will penetrate and work within, Technology *Push* allows innovators to keep their options open when discussing where a new technology will be applied. So, according to the type of work being developed, different methodologies may be more suited for that particular innovative effort.

Business Model Patterns

Great potential also exists in the creation of new business models in the various areas of Agriculture, as well as the modification of existing ones. Various efforts have been made to modify and improve existing business models in the agri-food business, particularly in livestock farming (de Olde, Carsjens et al. 2017). Nonetheless, the study of the use of Business Models, and the innovation of said Business Models, remains rare (Tell, Hoveskog et al. 2016). As shown throughout this research work, there are significant opportunities in each of the agricultural areas studied to innovate, in terms of how business is done. Particularly, the possibility of using business models from other areas that improve the relationship between the consumer and the farmer may be of interest, as most small and medium scale farms will need to bring some additional advantage to the client in order for him/her to be able to relate and trust this particular farm. Additionally, business models that improve and make it easier for clients to have access to and buy agricultural products are also of great interest, as improving the logistics of the transaction between the client and the producer will, once again, help improve the relationship between them, and establish an easier channel of communication between them. Thus, there are still various improvements to be made in terms of how business models work in Agriculture and so innovation in this area may bring great benefits to both the farmers, potentially improving their customer base and

revenue streams, and the consumer, by possibly bringing better products in a more efficient fashion.

As a whole, with this exploratory research work it was possible to answer the main research question “How can the different entrepreneurial tools (Business Model Patterns, Technology Push and Lead User) be used for the creation, development and management of innovation in Agriculture?”. During this work, it was demonstrated that any of the tools under analysis can, and have been used, in an effective way in Agriculture. Despite this, a clear focus on the Lead User method and the importance of the opinions of farmers in the development of new technologies was displayed. While Technology *Push* remains a viable method to be used, through a Lead User methodology innovators are able to directly answer the challenges that farmers face at the moment. Since Agriculture is an activity in which the producer plays a pivotal role in the production of good and fresh products, making their work easier is crucial for the production of quality products that people all around the world will be able to take advantage of.

Additionally, the secondary research question “What has been the interaction between the different actors of this developmental chain for the creation, development and management of innovation in Agriculture?” was also answered effectively. Though the farmers interviewed claimed that no interaction existed between them and researchers or entrepreneurs, they were willing to work with these actors in such a manner that would eventually lead to the development of new products that would benefit them. On the other hand, the feedback displayed by the researcher and entrepreneurs demonstrated the great importance they attributed to the interaction that exists between them and farmers. Through the information given to them by farmers, researchers and entrepreneurs are able to not only develop new products that are more suited to the farmers’ needs, but also continuously improve these innovations, once again according to what the farmer gives as feedback.

5. Conclusions

The main purpose of this research was to understand how innovation has been performed in Agriculture, particularly in terms of how different tools (Business Model Patterns, Technology *Push* and Lead User), if any, had been used, and how they were applied, in Agriculture. This analysis was done through both a literature review encompassing the main themes of Innovation, Agriculture and Entrepreneurship, as well as through interviews with various actors that are of importance to the Agricultural Value Chain.

Through the research work, it was possible to determine that all of the studied tools have been, at some point, used for the creation of innovation in Agriculture. Nonetheless, the Lead User method, according to the interviews, was shown to be the method of preference. This is due to the great level of interactivity that occurs between the developers of the innovation and the end-user, which are allowed by this type of method. As farmers are in constant contact with the agricultural environment due to their activities, they are also able to determine immediately which challenges have arisen in their area of work. Thus, this type of interaction brings an advantage also to researchers and entrepreneurs, by keeping them in constant contact with the everyday challenges of Agriculture. Accordingly, researcher, entrepreneurs and farmers expressed their interest in that the end-user has a say, since the start, on which direction an innovation should be develop towards, and how this innovative solution should be improved afterwards.

In spite of this, the viability of the Technology *Push* method was also displayed. Both in previous works of research teams, and also in the case of *Wisecrop*, Technology *Push* allowed innovators to develop a technology first and then enter the market of Agriculture in such a way that eventually farmers exhibited acceptance and excitement for the product. Even so, the importance of user feedback was once again expressed, as the information that users give to the developers is of great help when discussing the improvement of the innovation.

Business Model Pattern analysis was also performed during this research work. Business Model Canvas studies in the area of Agriculture have been the most common entrepreneurial tool found when discussing the use of entrepreneurial tools in Agriculture. Nevertheless, in this work the author aimed to determine whether Business Model Patterns could possibly help improve existing areas of business in Agriculture, acting as an innovation. According to the results this type of analysis is possible, however the innovator must have some kind of knowledge regarding the existing business models in that area. Through the use of Business Model Patterns, it was possible to not only create new manners of developing a business in Agriculture, but also improve already existing business models. This effort, specifically when discussing Agriculture, may lead to an improvement in the relationship between the producer and the customer, and so lead to benefits not only to the farmer, but also the paying consumer.

A secondary research question was also answered, regarding the type of interaction that exists between the various actors that are involved in the Agricultural Value Chain. According to the research, all of the actors interviewed indicated that a certain kind of relationship must occur between researchers or entrepreneurs, and farmers. Both researchers and entrepreneurs admitted not only that they currently develop these kinds of relationships with producers, but also that the information received from these interactions is crucial for the success of the innovation. The farmers interviewed, on the other hand, indicated that they did not have any kind of relation or interaction with any researcher or entrepreneurs. As such, finding ways to establish this kind interaction between the different actors may prove to be of great importance, as creating and nurturing these types of relationships will only lead to an improvement in the innovative efforts that are made directed towards Agriculture.

In conclusion, through this research work it was possible to observe that the various tools can, and should, be used in Agriculture, since they bring various benefits to both the innovators, and the end-users. Nevertheless, avenues must be created so that the interaction between innovators and the end-users is natural and benefiting for both. From Technology *Push* to Lead User method, through different paths, the goal is the same: to create new and innovative products that not only make life easier for farmers, but make life better for society as a whole.

Limitations and Recommendations

During this research work, several limiting factors hindered the realization of an effective and all-encompassing research study. First, as the time for the development of the research work was 6 months, this time frame proved to be too little for a comprehensive analysis on how innovation is performed in Agriculture. Not only there were limits to the amount of people interviewed, but also limits to the geographical area of where these people came from. As such, an increased time frame for a more complex and complete analysis would be needed in a future project.

Additionally, as this was merely an exploratory analysis, the sample proved to be very variable. While it was possible to interview people from the three main actors of the Agricultural Value Chain, there was no triage of which type of farmer, entrepreneur and researcher was interviewed, due to lack of time. Accordingly, a much more comprehensive triage analysis must be performed in a future work.

Finally, the geographic limitation of this study cannot be understated. All of the analysis was done having in mind Portugal, despite the literature review involving innovative efforts in Agriculture all over the world. As such, in a future work there must be an effort to improve the range of countries analysed.

Future Work

Various aspects can be further developed in future works. First, and as mentioned before, a more comprehensive analysis may be of interest, involving not only a larger and better developed sample of persons interviewed, but also a larger number of countries under analysis.

Furthermore, additional studies may be focused on the individual tools. As seen before, the literature regarding the use of these tools in Agriculture, both together and individually, is largely scarce. As such, developing researching efforts focused on the importance and effectiveness of Technology *Push*, Lead User method, and Business Model Patterns in Agriculture may be of great importance, in order to understand not only how innovation is done in Agriculture, but also how which tool can be used, and possibly modified.

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ANNEX

Table 3. Literature Review for the Topic “Innovation in Agriculture”

Authors and Year	Title	Source Title	Keywords	Focus of Research
(Long, Blok et al. 2016)	“Barriers to the adoption and diffusion of technological innovations for climate-smart agriculture in Europe: evidence from the Netherlands, France, Switzerland and Italy”	Journal of Cleaner Production	“Sustainability”, “Climate-smart”, “Innovation adoption”, “Key socio-economic barriers”,	Identify key barriers which prevent the adoption of climate-smart agriculture technological innovations in various European countries, through interview surveys. Barriers on both the demand and supply sides were found.
(Kubankova, Hajek et al. 2016)	“Environmental and social value of agriculture innovation”	Agric. Econ	“Sustainability reporting”, “Environmental issues”, “Social effects”	Using a specific case study, there was a development of a sustainability analysis regarding this case study, understanding also the social and environment issues surrounding this agricultural innovation, in order to determine the best practices in agricultural innovation
(Busse, Doernberg et al. 2014)	“Innovation mechanisms in German precision farming”	Precision Agric	“Sectoral innovation system”, “Delphi survey”, “Precision Farming”, “Barriers”, “Knowledge transfer”, “Political environment”, “Adoption factors”	Analysis of the innovation mechanisms in the precision farming innovation process chain, determining possible barriers and challenges to its success, as well as determining the main adoption factors
(Alarcón and Sánchez 2016)	“Is there a virtuous circle relationship between innovation activities and exports? A comparison of food and agricultural firms”	Food Policy	“Food and agriculture industry”, “Food innovation”, “Internationalization”, “Determinants of innovation”, “Competitive advantages”	Study of the existence of a relation between innovation decisions and exports for food and agriculture industries, presenting possible important factors for this relationship
(Cullen, Forbes et al. 2013)	“Non-adoption of environmental innovations in wine growing”	New Zealand Journal of Crop and Horticultural Science	“Adoption of environmental innovation”, “Social benefits”, “Limited commercial benefits”, “Targeted policies”	Study regarding the establishment of ecologically and sustainably focused practices so as to determine its effects on both potential social and commercial benefits derived from the implementation of an environmental innovation
(Lubell, Hillis et al. 2011)	“Innovation, Cooperation, and the Perceived Benefits and Costs of Sustainable Agriculture Practices”	Ecology and Society	“Cooperation”, “Knowledge gaps”. “Knowledge networks”, “Economic benefits”, “Social benefits”, “Sustainability outreach programs”	Assessment of the perceived costs and benefits of sustainable viticulture practices recommended by sustainability outreach and certification programs, in order to determine possible issues relevant for the sustainability of agricultural practices

(Janssen and van Ittersum 2007)	“Assessing farm innovations and responses to policies: A review of bio-economic farm models”	Agricultural Systems	“Agricultural systems”, “Farmer decision making”, “Policy changes”, “Multi-functional agriculture”, “Bio-economic farm modelling”, “Model evaluation”	Review of past works regarding Bio-economic farm models, analysing their strengths and weaknesses, when used to assess technological innovations and policy changes, presenting key issues involved in the agricultural activity
(Ervin, Glenna et al. 2010)	“Are biotechnology and sustainable agriculture compatible?”	Renewable Agriculture and Food Systems	“Agricultural biotechnology”, “Environmental benefits”, “Socio-economic benefits”, “Genetically Engineered crops”, “User engagement”	Analysis of the sustainability frameworks that influence the use of agricultural biotechnology, acknowledging the impact of these innovations in both environmental and socio-economic areas
(Rezaei-Moghaddam and Salehi 2010)	“Agricultural specialists' intention toward precision agriculture technologies: Integrating innovation characteristics to technology acceptance model”	African journal of agricultural research	“Precision agriculture”, “Environmental improvement”, “Technology acceptance model”, “User response to innovation”	Study of the response by users toward the adoption of precision agriculture technologies in Iran, through a survey, determining the importance of the opinion of said users
(das Chagas Oliveira, Calle Collado et al. 2012)	“Peasant Innovations and the Search for Sustainability: The Case of Carnaubais Territory in Piauí State, Brazil”	Journal of Sustainable Agriculture	“Agroecological transition”, “Self-made technology”, “Farmer knowledge”, “Socio-economic needs”, “Environmental needs”	Assessment regarding the sustainability presented by innovations developed by farmers, and their influence on various socio-economic factors
(Leach, Rockström et al. 2012)	“Transforming Innovation for Sustainability”	Ecology and Society	“Dry land agriculture”, “Rural energy”, “Transformative innovation”, “Multi-scale innovation politics”, “Sustainability brokering”	Understanding, through different case studies, the need for new forms of innovation, including the integration of grassroots movements and actors into this activity, as well as the development of new innovation politics
(Sumberg, Heirman et al. 2013)	“From Agricultural Research to ‘Product Development’”	Outlook on Agriculture	“User involvement”, “New Product Development”, “Feedback generation”,	Development of work, within the case study, in order to understand the importance of user involvement when developing a new product, through the use of feedback and feedback loops
(Popper 2008)	“How are foresight methods selected?”	Foresight	“Research methodology”, “Strategic planning”, “Decision making”, “Foresight”, “Multi-factor process”,	Analysis of best foresight methods to be used, according to the aim of the study, as well as the experience of the investigator

(Mekonnen, Spielman et al. 2015)	“Innovation Systems and Technical Efficiency in Developing-Country Agriculture”	Agriculture Economics	“Technical efficiency”, “Existing resources”, “Production frontier”, “Educational enrolment”,	Analysis of technical efficiency and agricultural production taking into account the agricultural innovation systems framework the different domains that are a part of the technological, social and economic environment
(Chetan Dwarkani, Ganesh Ram et al. 2015)	“Smart Farming System Using Sensors for Agricultural Task Automation”	2015 IEEE Technological Innovation in ICT for Agriculture and Rural Development	“Smart strategies”, “Technical measurements”, “Increase in competence”	Development of a smart irrigation and sensing system for automation of activities in an agricultural environment, in order to increase efficiency
(Janssen, Athanasiadis et al. 2011)	“Linking models for assessing agricultural land use change”	Computers and Electronics in Agriculture	“Agricultural land use modelling”, “Multi-scale analysis”, “Model interlinkage”, “Changes in domains”	Development of a system capable of linking different types of models used to assess agricultural land use, so as to improve the analysis developed through the integration of the different domains involved in agriculture
(Nasiakou, Vavalis et al. 2016)	“Smart energy for smart irrigation”	Computers and Electronics in Agriculture	“Reduction of costs”, “Smart energy production”, “Software integration”, “Effective energy configurations”	Development of a software platform that integrates both smart energy and smart irrigation systems, in order to effectively reduce costs to the producer, increasing sustainability
(Temple, Kwa et al. 2011)	“Organizational determinant of technological innovation in food agriculture and impacts on sustainable development”	Agronomy for Sustainable Development	“Food security”, “Limited natural resources”, “Market needs”, “Interaction”, “Different disciplines”, “Hybridization”	Analysis of a case study, insofar as to understand the impact of institutional innovation, and the social and economic environments in rural areas, in what pertains to agriculture
(Flavell 2017)	“Innovations continuously enhance crop breeding and demand new strategic planning”	Global Food Security	“Genome editing”, “Idea adaptation”, “Food security”, “Plant engineering”, “Breeding strategies”, “Innovation Control”	Study of innovative efforts in plant genomics to create products that can help improve food security, and the role of the various actors involved in the process of innovation in order to control its effects and social view in the world
(Horbach, Rammer et al. 2012)	“Determinants of eco-innovations by type of environmental impact — The role of regulatory push/pull, technology push and market pull”	Ecological Economics	“Eco-innovation determinants”, “Improved environmental performance”, “Process innovation”,	Study of if and how different types of eco-innovations are driven by various types of factors, with a focus on government regulation, cost savings and customer benefits
(Kleijn and Sutherland 2003)	“How effective are European agri-environment schemes in conserving and promoting biodiversity?”	Journal of Applied Ecology	“Biodiversity conservation”, “Environmental impact”, “Agri-environment schemes”, “Ecological evaluation”	Analysis of the efficiency of agri-environment schemes that are used to conserve and promote biodiversity conservation and enhancement, through a study of evaluation studies that were developed on this area

(Knols, Bossin et al. 2007)	“Transgenic mosquitoes and the fight against malaria: managing technology push in a turbulent GMO world”	Am J Trop Med Hyg	“Genetic modification”, “Public health gains”, “Technology implementation”, “Stakeholder involvement”, “Collaborative research”	Analysis of how research work is developed in the area of genetic modification of mosquitos, and how the innovations are translated from a laboratorial setting to open field trials, so as to determine how this process should occur and be managed
(Luong, Male et al. 2008)	“Biosensor technology: Technology push versus market pull”	Biotechnology Advances	“Biosensor technology”, “Cost considerations”, “Technical barriers”, “Versatility”, “Miniaturization”, “	Determination of how biosensor technology must be brought on from a laboratorial setting to the commercial market, in order to establish the potential limitations that occur regarding this type of technological transfer
(Paraginski 2014)	“A natureza das inovações em agroindústrias de arroz do Rio Grande do Sul”	Revista de Administração e Inovação	“Demand-pull”, “Technology-push”, “Literature research”, “Value Chain analysis”	Study of how radical and incremental innovations, specifically in rice’s agroindustries are developed, through the use of a Value Chain analysis
(Tindley and Wodehouse 2014)	“The Role of Social Networks in Agricultural Innovation: The Sutherland Reclamations and the Fowler Steam Plough, c.1855-c.1885”	Rural History	“Creativity”, “Efficiency”, “Industrial and agricultural processes”, “Collaboration”, “Networking”, “Rural innovation”	Analysis of an example related to the development of the Fowler Steam Plough, and the analysis of how social networking helped created and grow this technological innovation

Questions developed for the interviews with farmers

Question 1: What is, in your perspective, Innovation and Innovation in the context of Agriculture.

Question 2: What do you believe Innovation can bring in to agriculture?

Question 3: What innovations have you knowledge of, or even developed yourself?

Question 4: Through which did you bring that idea to life, and applied it in a practical way?

Question 5: How have you related these technologies to the area of Agriculture, and applied them into that specific market?

Question 6: What contact do you have commonly with scientific researchers regarding new technologies, and what is the importance of that type of interaction?

Question 7: Which approach do you consider more effective towards the creation of innovative ideas in Agriculture, a more technological approach, or an approach based on the needs of the farmers?

Question 8: Do you have any ideas about possible areas in Agriculture where there is yet to be significant innovations?

Question 9: Currently, what challenges have arisen during your Agricultural work, which has not been answered yet?

Question 10: In basic terms, how does your business model work?

Questions developed for the interviews with researchers

Question 1: What is, in your perspective, Innovation and Innovation in the context of Agriculture.

Question 2: What do you believe Innovation can bring in to agriculture?

Question 3: Have you worked on any significant project regarding new technologies that are directed towards Agriculture? How did that type of project occur and what has been their success?

Question 4: How have you related these technologies to the area of Agriculture, and applied them into that specific market?

Question 5: Do you commonly have contact with farmers, in order to obtain their feedback on the innovative technologies they come into contact with, or even develop themselves?

Question 6: What is the best way, in your opinion, to connect and improve the interaction between researchers and farmers, in order to make the process of innovation more efficient and productive?

Question 7: Which approach do you consider more effective towards the creation of innovative ideas in Agriculture, a more technological approach, or an approach based on the needs of the farmers?

Question 8: Do you have any ideas about possible areas in Agriculture where there is yet to be significant innovations?

Questions developed for the interviews with entrepreneurs

Question 1: What is, in your perspective, Innovation and Innovation in the context of Agriculture.

Question 2: What do you believe Innovation can bring in to agriculture?

Question 3: How did the idea for the development of an innovative product/service directed towards Agriculture came to be? What were the main steps taken towards establishing a finished product from that initial idea?

Question 4: What was done to create and develop the market for that technology?

Question 5: Do you commonly come into contact with farmers, in order to obtain their feedback on the product? If so, what is the importance of that interaction between different sides of the same market?

Question 6: Which approach do you consider more effective towards the creation of innovative ideas in Agriculture, a more technological approach, or an approach based on the needs of the users?

Question 7: Do you have any ideas about possible areas in Agriculture where there is yet to be significant innovations?

Question 8: Do you have any ideas about possible areas in Agriculture where there is yet to be significant innovations?